A Dynamic Approach to Germany's Unemployment Problem

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Abstract

This dissertation consists of theoretical and empirical contributions to the literature on search and matching, with a particular focus on the German labour market. The first chapter provides an introduction to the search and matching model of the labour market and its empirical counterpart, the flow approach to labour market dynamics. The second chapter investigates the consequences of endogenizing the job destruction decision in a model with skill mismatch. This leads to two key insights: on the one hand, raising unemployment benefits in the model leads to a longer expected duration of post-unemployment job matches. On the other hand, an increase in skill mismatch in the aggregate production function lowers the level of unemployment in an economy with high unemployment benefits. The third chapter empirically investigates worker flows in the West German economy using data derived from social security records provided by the Institute for Employment Research. After providing stylised facts on the cross-sectional and the time-series features of gross worker flows, their cyclical properties are investigated. Separations are found to be less volatile than hirings; however, the flatness of separations is shown to hide important compositional changes over the business cycle, i.e. the flows underlying separations are relatively volatile. Furthermore, an econometric panel data analysis shows that a major reason for workers becoming unemployed during a recession is a reduction in the hiring activity of firms, which is witnessed by a reduction in direct job-to-job transitions. The fourth chapter uses the same data set in order to examine the interaction between structural change and labour market dynamics. An important finding is that the pace of sectoral reallocation accelerated around 1990 in the West German economy, and did not recede to previous levels afterwards. Sectors are shown to differ in employment growth rates because of differences in inflow rates, rather than outflow rates. Growing sectors recruit most of their workers from non-participation, while for shrinking sectors, flows to and from unemployment also play an important role. Direct job-to-job transitions, while being crucial for the cyclical dynamics of the labour market, are negligible with respect to sectoral reallocation.

Keywords:
Unemployment, search and matching, mismatch, endogenous job destruction, accessions, separations, worker flows, job-to-job, business cycle, structural change, sectoral transformation

Zusammenfassung

Diese Arbeit besteht aus theoretischen und empirischen Beiträgen zur Such- und Matchingliteratur, wobei der Schwerpunkt auf dem deutschen Arbeitsmarkt liegt. Das erste Kapitel beschreibt das Such- und Matchingmodell des Arbeitsmarktes sowie sein empirisches Gegenstück, den Flussansatz. Das zweite Kapitel untersucht, welche Auswirkungen die Endogenisierung der Jobzerstörung in einem Modell mit skill mismatch hat: Eine Anhebung der Arbeitslosenunterstützung führt zu einer längeren erwarteten Dauer des der Arbeitslosigkeit folgenden Beschäftigungsverhältnisses. Andererseits senkt ein Anstieg von skill mismatch in der aggregaten Produktionsfunktion die Arbeitslosenrate. Das dritte Kapitel liefert eine empirische Untersuchung der Arbeiterflüsse in Westdeutschland auf Basis von Daten des Sozialversicherungssystems, die vom Institut für Arbeitsmarkt- und Berufsforschung (IAB) zur Verfügung gestellt werden, verwendet werden. Nach einer Darstellung der Querschnitts- und Zeitreiheneigenschaften dieser Flüssewird deren Zyklizität untersucht. Trennungen sind weniger volatil als die Bildung neuer Beschäftigungsverhältnisse. Jedoch verbirgt die relativ geringe Volatilität der Trennungen starke Schwankungen ihrer Zusammensetzung. Eine ökonometrische Untersuchung zeigt, dass ein wichtiger Grund für Arbeiterflüsse in die Arbeitslosigkeit während einer Rezession der Rückgang der Einstellungsneigung von Firmen ist, was auch aus dem Rückgang der direkten Job-zu-Job-Übergänge ersichtlich ist. Das vierte Kapitel verwendet den gleichen Datensatz, um die Interaktion zwischen strukturellem Wandel und Arbeitsmarktdynamik zu untersuchen. Ein wichtiger Befund ist, dass die Geschwindigkeit der sektoralen Reallokation um das Jahr 1990 in Westdeutschland erheblich und dauerhaft zunahm. Unterschiede im Beschäftigungswachstum zwischen Sektoren lassen sich auf unterschiedliche Zugangsraten (nicht Austrittsraten) zurückführen. Neue Beschäftigungsverhältnisse werden in wachsenden Sektoren vor allem mit Hilfe von Arbeitern aus der Nichterfassung, in schrumpfenden Sektoren auch mit Hilfe von Arbeitslosen, gebildet. Direkte Job-zu-Job-Übergänge spielen bei der sektoralen Reallokation so gut wie keine Rolle, obwohl sie für die zyklischen Eigenschaften des Arbeitsmarktes äußerst wichtig sind.

Schlagwörter:
Arbeitslosigkeit, Suche und Matching, Mismatch, endogene Jobzerstörung, Zugänge, Trennungen, Arbeiterflüsse, Job-zu-Job, Konjunkturzyklus, struktureller Wandel, sektorale Transformation

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Πάντα ρεῖ - Everything flows.

HERACLITUS (C.535-475BC)

Chapter 1

Introduction and Overview

1.1 Introduction

Unemployment has been one of the most pressing economic and social problems in Western Europe since the end of the 1970s. For those affected, unemployment causes material want, social exclusion, and psychological and health problems, to name but a few. Furthermore, from a macroeconomic perspective, unemployment leads to a loss of production, to a loss of human capital (especially in the case of long-term unemployment), and to a worsening of the public finances. As a consequence, the fight against unemployment has been high on the political agenda, and it has attracted an ever rising interest from academic researchers. Despite much effort, however, the problem is far from being solved in a number of European countries. The Western European economies[1] where unemployment has been particularly severe include the large continental countries, namely France, Germany, Italy, and Spain. Countries such as Great Britain and some smaller European countries (Austria, Holland) have been much less affected recently, with unemployment rates ranging around 5%. Table 1.1 depicts 5-year averages of unemployment rates of different European countries and the United States, the latter being

[1]The situation of the formerly communist countries in Central and Eastern Europe is a very important topic as well. However, because a completely different analysis is required in this case, it is beyond the scope of this study.

commonly used as a benchmark. There, the unemployment rate only features cyclical factors. Looking at Europe, one can see that large heterogeneities exist even within the two broad groups of economies mentioned above. In France and Western Germany[2], unemployment started to rise in the mid- to late 1970s. It continued to rise throughout the 1980s and early 1990s, and has not come down considerably since. Spain, on the other hand, saw its unemployment rate reach its peak in the early 1990s. Since then, unemployment has been falling rapidly, reaching 8.5% in December 2006.[3] Given the diversity of unemployment experiences, it is to an extent misleading to speak about *the* European unemployment problem. When I do so nevertheless, I think of the key stylised fact characterising the large European economies, namely rising and persistent unemployment since the 1970s. Different explanations for this evolution of European unemployment rates have been put forward. In the 1970s, when unemployment started to increase significantly,

Table 1.1: Unemployment rates for different countries over time

Country	Years							
	1971 -2005	1971 -1975	1976 -1980	1981 -1985	1986 -1990	1991 -1995	1996 -2000	2001 -2005
Austria	4.7	1.8	2.0	4.0	5.3	6.3	6.8	6.9
France	8.5	3.1	5.6	9.0	9.9	11.0	11.2	9.5
Germany	6.0	1.8	3.5	6.8	6.8	6.4	8.0	7.7
NL	5.7	1.8	3.3	8.8	8.0	7.4	5.3	5.2
Spain	11.8	2.9	6.0	14.6	14.6	16.2	14.3	10.4
UK	7.2	4.1	5.7	11.0	8.9	9.5	6.5	5.0
US	6.2	6.1	6.8	8.3	5.9	6.6	4.6	5.4

Notes: All rates averaged over 5-year intervals and expressed in per cent. Spanish data starting in 1973; Germany: only western part. NL stands for Netherlands. See Appendix A.1 for the data sources.

[2] In the entire thesis, I only consider Western Germany. The reasons for this are, first, that this makes it possible to work with consistent time series going back to the 1970s, and second, that the labour market in Eastern Germany differs significantly from the one in Western Germany. A unified treatment would therefore do justice to neither part of the country. For analyses of the Eastern German labour market, see Burda and Hunt (2001) and Hunt (2007).

[3] Source: *The Economist*, 24th February 2007.

most researchers focused on the factors leading directly to a rise of the unemployment rate. The shocks that were identified at the time were oil price hikes and the slowdown in total factor productivity, together with nominal and real rigidities. When these shocks abated and unemployment did not fall in many countries, the analysis of persistence mechanisms gained centre stage. The main suspects were monetary policy committed to lowering the inflation rate, capital accumulation, and labour market institutions. More recently, the role played by the interaction of shocks and institutions has attracted much attention. Both the analysis of persistence mechanisms and the interaction of shocks and institutions was greatly helped, from the late 1980s, by the flow approach to the labour market, together with the search and matching model. This approach provided a new and powerful tool for the analysis of the factors influencing labour market dynamics, and will also be pursued in the present thesis.

There are many excellent surveys of the analysis of unemployment in European countries, and of search and matching models and the flow approach.[4] The purpose of this chapter is therefore not to give an exhaustive survey. Rather, it is intended to act as a roadmap to illustrate what labour economists already knew in the 1980s and 1990s, and which new insights are provided by current research in labour economics, especially by the search and matching model and the flow approach to the labour market.[5] I proceed as follows. First, I give a brief overview of the evolution of academic research on unemployment in Europe since the late 1970s. Second, I describe the search and matching model in more detail. Third, I illustrate how the flow

[4]Bean (1994) reviews general research on European unemployment. Phelps (1994) investigates the effects on unemployment of a specific form of efficiency wages in the labour market, and firms investing in a customer base in the product market. Mortensen and Pissarides (1999b) and Blanchard (2006) mainly focus on the analysis of unemployment using the flow approach. Theoretical and empirical search models are reviewed by Rogerson et al. (2005) and Eckstein and van den Berg (2006), respectively. Pissarides (2000) is authoritative for the search and matching model discussed below.

[5]It should be pointed out that we are dealing with the *unemployment*, not the *employment* problem in Europe. The issue of labour force participation is clearly an important one (cf., for example, Rogerson, 2005). Nevertheless, as we follow the search and matching literature, we implicitly consider the labour force to be fixed.

approach to the labour market is being used to analyse factors influencing labour market dynamics, such as labour market institutions. Fourth, I briefly discuss the literature on the dynamics of the German labour market. The last section explains how I contribute to the existing literature by presenting a short synopsis of the chapters of this thesis.

1.2 Analysing "European Unemployment": A Bird's Eye View

When unemployment started rising across industrialised countries in the 1970s and early 1980s, the main focus of economic researchers was on two shocks that may have led to this development. First, there was a marked slowdown in total factor productivity (TFP) (cf. Maddison, 1987). Second, oil prices increased sharply, especially at the end of the 1970s. Bruno and Sachs (1985) argued that these shocks, together with real and nominal wage inertia, could explain the rise in unemployment. Real wage inertia means that workers are not adjusting their real wage demands, i.e. they are asking for too high a wage, when warranted real wages fall, e.g. because of a fall in TFP. In contrast to that, nominal wage inertia implies a greater variability of real wages when the price level changes. As real and nominal wage inertia in a given country are determined by the structure of the economy, differences between countries in these two types of rigidities are likely. Therefore, countries featuring different levels of real and nominal wage inertia was seen as an explanation for differences in their unemployment experiences. Given this kind of explanation, which focused on the impact of initial shocks, most economists expected unemployment to return to its previous, low, levels once the effect of the oil price hike had abated, and once the agents in the economy had adapted their expectations to the slowdown in productivity. However, these hopes did not come true, and unemployment remained stubbornly high during the 1980s. Therefore, the focus of economists turned to the question what prevented the unemployment rate from falling back to its previous levels.

As pointed out above, the three main suspects leading to persistently high unemployment were monetary policy, capital accumulation, and labour market institutions. Monetary policy was used to bring down inflation rapidly in many countries in the late 1970s and the early 1980s. However, the effects of this policy are unlikely to still have been felt in the late 1980s or even in the 1990s. Capital accumulation, on the other hand, was seen to fall as unemployment was rising. Falling employment in turn could lead to a reduction of the profit rate, which would further reduce investment in capital and labour. This self-reinforcing downward spiral was seen as a source of persistence.[6] However, this explanation is mainly relevant as a persistence mechanism in case unemployment starts to fall rapidly. While this might be important in the future, it is not the topic of interest here. I therefore focus on the remaining culprit for the persistence of unemployment, namely the inappropriateness of labour market institutions. The importance of institutions for determining the persistence of unemployment as well as cross-country differences, gained centre stage through the publications by Layard et al. (2005)[7] and the Organisation for Economic Co-operation and Development (OECD, 1994). The institutions which received most attention were those related to collective bargaining (cf. Blanchard and Summers, 1986, and Lindbeck and Snower, 1986, 2001), unemployment benefits (cf. Burda, 1988, Atkinson and Micklewright, 1991), employment protection (Lazear, 1990), minimum wages (Dolado et al., 1996), and the tax wedge (Bean et al., 1986). These institutional factors are able to explain a large proportion of the cross-country variation in unemployment rates in either the 1980s or the 1990s, as shown by Nickell (1997). He found the following to raise the level of unemployment: high levels of unemployment benefits if they go together with poor monitoring and an indefinite entitlement period; high and non-coordinated unionisation; high overall taxes impinging on labour. This was not the case for the mere level of unemployment benefits, strict employment protection

[6] Cf. Drèze and Bean (1990) for a summary of the related literature.

[7] This applies to the first edition of their book which appeared in 1991.

legislation, and unionisation, if the latter was highly coordinated.

While the research that focussed on institutions thus seemed to produce some interesting insights with respect to cross-country differences, it was not able to explain the evolution of unemployment *over time*. This was due to the fact that the institutional changes between the early 1970s and the 1990s were by far not strong enough in some countries (such as in Germany), or were complex and contradictory in other countries (such as in France, cf. Blanchard and Landier, 2002). This led Blanchard and Wolfers (2000), among others, to analyse the interaction of shocks and institutions.[8] Looking at a panel of 20 OECD countries for the time period 1960-1996, they estimate the impact of the interaction of common shocks and country-specific institutions on the level of unemployment. The shocks considered are the decline in total factor productivity growth, shifts in labour demand, and changes in the real interest rate. Using this methodology, they were able to explain much of the rise of unemployment in Europe over time, as well as the heterogeneity that exists in that respect across countries. With respect to specific institutions, they add a dynamic dimension to Nickell (1997), while generally confirming his results.

Another shock that has received much attention in the literature is the increase in mismatch.[9] The latter is witnessed by the outward shift of the Beveridge Curve since the early 1980s in many European economies. This shift means that there are more unfilled vacancies for a given number of unemployed. In other words, the matching process on the labour market has become less efficient. In this respect, there are important differences between the US and European economies. Both experienced an outward shift of the Beveridge Curve in the early 1980s. However, while this was later undone by a subsequent inward shift in the US, in many European economies the Beveridge Curve continued to move outwards in the following decades. This movement of the Beveridge Curve also points to the importance of the shift of employment away from manufacturing to services, which is a general feature

[8] To be fair, the idea was already present in Bruno and Sachs (1985), as described above.
[9] See, for example, the contributions in Padoa Schioppa (1991).

of mature industrialised economies. Early analyses of this issue (Fisher, 1935, Clark, 1940, Fourastié, 1949) were taken up in a business-cycle context by Lilien (1982). He argued that cyclical downturns are caused by sectoral shocks requiring the reallocation of workers between sectors, which causes frictional unemployment. Subsequent research (Abraham and Katz, 1986, Blanchard and Diamond, 1989) has been critical of this proposition, mainly because sectoral vacancy rates do not show important differences in labour demand between sectors during recessions. Nevertheless, as Layard et al. (2005) show, structural change is likely to be an important determinant of unemployment at least in the long run.

The analysis of unemployment in general, and of European unemployment in particular, was helped enormously by the development of a new model of the labour market, the search and matching model, as well as its empirical counterpart, the flow approach to the labour market. As this is the approach taken in this thesis, I now turn to a brief description of this theory.

1.3 The Search and Matching Model and the Flow Approach to the Labour Market

The neoclassical theory of the labour market posits a *frictionless* vision of the economy. A worker can provide as many hours as he chooses to at the market wage, and he can do so immediately and at no cost. While this is a sufficient modelling framework for some applications, in the present context it misses some crucial features, including the fact that job search implies a cost in terms of both time and money. It therefore has difficulties answering particular questions, such as why workers might turn down job offers, how unemployed workers and unfilled vacancies can coexist, what determines aggregate unemployment and vacancy rates, or why similar workers are paid differently. By taking imperfect information in the labour market into consideration, search theory is able to answer these and related questions.[10] Within this theoretical framework, models of *undirected search* have been used to analyse the general workings of the labour market which are related to labour market dynamics, i.e. to flows between different jobs and different labour market states.[11] Frictionless models which focus only on stocks are not able to do so. Explicitly considering labour market dynamics allows for a more careful analysis of the role of institutions. Many institutional features, such as unemployment benefits and employment protection, affect workers' incentives with respect to accepting employment and a given wage. The resulting effect on the wage distribution in turn has an impact on firms' hiring decisions. Thus, a rich set of channels through which labour market institutions operate can be analysed. Before discussing this in more detail in the next section, I give a brief outline of the theory.

Following Merz (2002), the literature on labour market search can be classified according to two distinct, but related, aspects. First, the *information gathering* approach stresses the fact that in a market where information, e.g. about wages, is incomplete, workers have to acquire this information somehow. Second, the *trade frictions* (or search frictions) approach emphasises the costly and time-consuming nature of the search process, which is due to trade frictions, rather than to information gathering about wages. Early search theory focused on the first aspect, and especially on the situation of unemployed workers searching for a job across firms which potentially pay different wages.[12] Unemployment can arise in these models because the worker is not

[10]Search theory is also used in a variety of other fields, such as in monetary economics (e.g. Kiyotaki and Wright, 1993) or in the marriage literature (e.g. Mortensen, 1988). When I refer to search theory, I solely mean the theory related to the labour market.

[11]There is also a large literature on search frictions and the formation of wages, which, however, is not the topic of this thesis. See, for example, Mortensen (2003), Rogerson et al. (2005), and Eckstein and van den Berg (2006) for comprehensive treatments of directed search and wage posting models.

[12]Stigler (1962), Phelps (1968), McCall (1970), and Mortensen (1970) are seminal papers. The model by Lucas and Prescott (1974) has workers searching over different markets ('islands'). However, as workers accept any wage, decision making is only about moving between different islands, and not about the decision whether to accept a wage offer. Mortensen (1986) provides an overview of early search theory.

able to find a job which offers a wage that he deems acceptable. Pissarides (1979), Diamond (1981, 1982a,b), and Mortensen (1982) were among the first to explicitly add "search frictions" to the information gathering approach in models of undirected search. Workers look for a job and firms open vacancies in order to find a worker. Because of informational imperfections, this takes time and is therefore costly. The two sides of the market are brought together by a *matching function* which is a black box modelling device for the trading frictions in the labour market.[13] The matching function determines how many productive matches are generated from a given number of (unemployed) workers and vacancies during a given time interval. Together with the equilibrium condition for worker flows (inflows equalling outflows), it entails the Beveridge curve, which links the unemployment rate to the vacancy rate. From a technical point of view, the matching function makes it possible to abstract from worker and firm heterogeneity, which greatly facilitates the modelling task. When a worker and a firm meet, they decide on whether it is worthwhile to form a match. If this is the case, they negotiate a wage and the match becomes productive. Wage negotiations in search and matching models usually follow the Nash (1950) sharing rule, where the surplus of the match is divided up according to the bargaining power of the parties involved.[14] In the standard case, a reservation wage rule governs the job acceptance decision: if the expected wage is equal to or above the reservation wage, the worker accepts the job offer, and rejects it otherwise. The firm always agrees with the decision of the worker. This is due to the facts that Nash bargaining corresponds to a maximisation of the joint surplus, and that the division of the surplus corresponds to the bargaining power of the firm and of the worker.[15] Thus, the decision of the worker also maximises

[13] See Petrongolo and Pissarides (2001) for an overview of both theory and empirics concerning the matching function.

[14] See Binmore et al. (1986) for a game-theoretic foundation of Nash's axiomatic approach. One of the few examples of a search and matching model using efficiency wages is Ramey and Watson (1997).

[15] Note that this applies only if workers do not search while employed. As Shimer (2006) points out, in models with on-the-job search, the set of feasible payoffs is typically non-convex, because a higher wage raises the duration of a match. Therefore, the axiomatic

the firm's surplus. The rate of unemployment arising in these models can been seen as a "natural" rate in the sense of Friedman (1968). He defined the natural rate of unemployment as the one which "would be ground out by the Walrasian system of general equilibrium equations, provided that there is embedded in them the actual structural characteristics of the labour and the product markets, including market imperfections, stochastic variabilities in demands and supplies, the cost of gathering information about job vacancies and labour availabilities, the costs of mobility, and so on." Search and matching models include important elements of this definition.[16] However, it is worth noting that the original idea of search is often only present indirectly (cf. Blanchard and Diamond, 1992). In many "search and matching models", turning down wage offers is not the prime cause of unemployment. Rather, trading frictions as represented by the matching function, give rise to frictional unemployment.[17]

The early search and matching literature (e.g. Pissarides, 1985) assumed exogenous job destruction, i.e. matches are destroyed by some exogenous process, which takes place with a certain probability during a given time interval. Mortensen and Pissarides (1994) endogenised the job destruction decision. In their model, productivity is governed by a stochastic process. The partners to a match decide whether production is worthwhile every time a productivity shock arrives, and wages are renegotiated accordingly. The question why the productivity of a match changes is usually left unanswered. Productivity changes might come from technology shocks, foreign competition, or shifts in aggregate demand. In that sense, the model only represents a partial equilibrium. The search and matching model has, however, also had an impact on general equilibrium macroeconomic modelling.

As Hall (1999) points out, the baseline neoclassical model (e.g. Kydland and Prescott, 1982, Campbell, 1994) is not able to properly account for sev-

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approach is not valid.

[16] It should be pointed out, however, that many of these models are not cast in a completely general equilibrium framework.

[17] Models featuring stochastic job matching are an obvious exception. See Jovanovic (1979) and Pissarides (1984) for seminal papers.

eral labour market phenomena. First of all, (involuntary) unemployment as such does not exist in this model. There are only two uses of time, employment and leisure (cf. Hall, 1999). Second, the baseline model cannot account for the fact that there are large movements into and out of unemployment in both upswings and recessions. This is also due to the adoption of the representative agent framework. In order to remedy these shortcomings of the baseline real business cycle-model, Merz (1995) and Andolfatto (1996) introduced job search into the dynamic stochastic general equilibrium (DSGE) framework. While these two authors assumed exogenous job destruction, Cole and Rogerson (1999), following Mortensen and Pissarides (1994), endogenised the job destruction decision and argued that their specification of the model can replicate the salient features of job flows in the US economy, given that the probability of finding a job is relatively low. Introducing elements of search and matching theory into DSGE models has the additional advantage of potentially being able to fix another weakness of the real business cycle approach, namely its lack of a sufficient internal propagation mechanism. This means that the dynamics of the model are very similar to the exogenous shock process which has an impact on the model. In other words, the vision put forward by Slutsky (1927) of a model transforming a white noise process into a stochastic process which resembles real-world data is clearly violated. The empirical results below are important for this problem. We therefore postpone a discussion of this issue to the next section.

One of the great advantages of the search and matching model is that its key ingredients, such as the matching function, as well as its outcomes, such as worker flows, are observable and hence estimable.[18] Thus, the analysis of labour market policies has been helped greatly.[19] Most importantly for our purpose, the model has been used extensively to analyse the general workings of labour market dynamics, i.e. gross worker flows, both with respect to its long-run properties and its cyclical properties. In particular, the model has given rise to the flow approach to the labour market. To this issue I now

[18] As an example, this is much more difficult for the efficiency wage model.
[19] See Eckstein and van den Berg (2006) for a recent overview.

turn.

1.4 The Flow Approach to the Labour Market in Practice

There is by now a large literature on gross job and worker flows.[20] The early literature (Blanchard and Diamond, 1989, 1990, Burda and Wyplosz, 1994) was mainly concerned with establishing the stylised facts about labour market dynamics. The conclusions drawn were as follows. First, worker flows are large. As I show in Chapter 3, roughly 25% of the workforce within a given year separate from their employer and access a new job in Western Germany. As another illustration, table 1.2 features unemployment inflow rates for five OECD countries, France, Germany, Spain, the UK, and the US. As one can see, the inflow rates range around 13% in France, Germany, and the UK, while they are considerably higher in Spain and in the US, an issue to which I return below.

Table 1.2: Unemployment inflows as share of the labour force, 1970-2005.

France	Germany	Spain	UK	US
14.3	11.9	45.7	13.4	30.2

Notes: Spanish data starting in 1973. Germany: only western part. See Appendix A.1 for the data sources. All figures in per cent.

Second, unemployment inflows and outflows move closely together, both over the long run and over the business cycle. The same is true for employment inflows and outflows. This is also witnessed by the fact that neither the stock of employment nor the stock of unemployment change rapidly. Third, the flow from employment to unemployment is countercyclical. The same is

[20] See Davis and Haltiwanger (1999) and Mortensen and Pissarides (1999a) for overviews concerning job and worker flows, respectively. The study by Davis et al. (2006) is more recent, but focusses solely on the U.S.. As the contributions in this thesis relate to worker flows, I do not consider the literature on job flows in detail.

true for the flow in the reverse direction, which is due to the fact that, in a recession, there are many short-term unemployed workers in the pool of the unemployed. Those workers have a high probability of being rehired quickly, which increases flows from unemployment to employment.

A final stylised fact related to worker flows is the strong procylicality of job-to-job transitions. As I show in Chapter 3 for the German labour market, the magnitude of job-to-job transitions is large. Furthermore, their cyclicality plays a key role for the dynamics of the entire labour market. I therefore discuss this topic in more detail. The existence of on-the-job search complicates the decision problem of the worker. As shown by Burdett (1978) in a partial equilibrium context, the optimal policy can be described by two reservation wages. The higher one determines below which productivity (or wage) level the worker searches on the job. The lower one specifies below which productivity level a match gets destroyed. A two-sided search model with on-the-job search is presented by Mortensen (1994). He shows that, in his model, a single macroeconomic disturbance can generate the empirically observed volatility and (negative) correlation of job creation and destruction, as well as the cyclicality of quits, and of unemployment inflows and outflows. Pissarides (1994) uses a similar model, but adds learning on-the-job in order to explain duration dependence of quit decisions. In his model, workers accumulate human capital on the job. Therefore, their incentive to search while employed declines with tenure. On-the-job search also plays an important role for the dynamics of the unemployment stock. Burgess (1993) shows that employed job seekers cause congestion for unemployed job seekers. As this reduces the flow from unemployment to employment during a business cycle upswing, unemployment persistence is increased. This effect is exacerbated through vacancy chains, which are caused by quitting (Akerlof et al., 1988). In a cyclical upswing, more employed workers engage in on-the-job search. As they leave their old job for a new one, a vacant position is created, which might in turn be filled by a previously employed worker, which creates another vacant position, etc.. In Chapter 3, I analyse in detail job-to-job transitions, as well as the importance of accessions and separations for worker flow dynamics in Germany.

As mentioned above, one of the great advantages of the flow approach to the labour market is its ability to analyse the incentive effects labour market institutions have for both workers and firms. To give a concrete example, consider the case of employment protection in the form of firing costs to the firm.[21] Using a search and matching model, three effects of this form of employment protection on worker flows can be shown (cf. Ljungqvist, 2002). First, higher dismissal costs reduce firings and hence the flow of workers into unemployment. Second, the bargaining power of employed workers rises, which raises the average wage level. As this reduces the value of a vacancy to the firm, hirings, and therefore flows into employment, fall. Thus, overall turnover is reduced. Third, as both hirings and firings go down, the overall effect on unemployment is not clear. These theoretical findings are borne out by the empirical evidence: cross-country comparisons show that firing costs clearly reduce worker turnover; the effect on the level of unemployment, however, is not clear-cut (cf., e.g., Blanchard and Portugal, 2001). Boeri (1999) points out a fourth effect, namely, that job-to-job transitions increase with rising employment protection legislation. In countries with high firing costs, the adjustment of the employment stock of firms thus takes place more via job-to-job transitions than in countries with low firing costs. These transitions enable firms to maintain a certain amount of flexibility with respect to their employment stock while saving on firing costs.

Another example is the case of unemployment benefits (cf. Pissarides, 1998). The latter influence the decision workers take with respect to accepting a wage offer. This in turn has consequences for a firm's decision on both whether to post vacancies and whether to destroy an existing match. Thus, the interaction of altered incentives on both sides of the market determines the ultimate effect of unemployment benefits. Two clear theoretical

[21] As Burda (1992) points out, firing costs have a different impact depending on whether they are a compensation which is paid to the worker, or a mere cost to the firm. Our discussion only applies to the latter case.

predictions emerge from this type of analysis: both the duration and the level of unemployment increase as the level of benefits rises. This is due to the fact that workers raise their reservation wage which reduces job acceptance. However, there are at least two caveats to the conclusions reached by this strand of the literature on the effects of unemployment benefits.[22] First, is important to realise that there are two important dimensions to unemployment benefits: first, the level of benefits, and second, the length and the conditionality of the entitlement period. It turns out that econometric studies find the second dimension to be much more important than the first one (cf. Fredriksson and Holmlund, 2006). Second, the models described above treat workers as *ex ante* homogeneous. This means that unemployed workers do not possess different skills, and therefore expected labour market outcomes are identical. Differences between workers only arise *ex post*, when productive worker-firm matches are hit by idiosyncratic productivity shocks. Once one takes into account *ex ante* heterogeneity, one has to deal with the fact that unemployment benefits provide a subsidy to search.[23] This means that higher unemployment benefits enable workers who dispose of specific skills to be more selective with respect to the job offers they receive. As in models with *ex ante* homogeneity, this raises the reservation wage. The additional effect with *ex ante* heterogeneity is that workers are more likely to choose a job which suits their specific skills, which increases the quality of matches. The empirical evidence shows that both effects indeed play a role.[24]

[22] Cf. Atkinson and Micklewright (1991) for an extensive treatment of this topic.

[23] The classic reference is Burdett (1979). The model by Marimon and Zilibotti (1999), which is the starting point of Chapter 2, analyses this mechanism within a search and matching model.

[24] In their seminal paper, Ehrenberg and Oaxaca (1976) find a positive effect of unemployment benefits on post-unemployment wages for the US labour market. Addison and Blackburn (2000) provide a review of the literature which suggests a weak effect of unemployment benefits on post-unemployment wages. Meyer (1990) finds that the exit rate out of unemployment increases the closer workers get to the time of benefit exhaustion. More recently, Tatsiramos (2006) shows for six European countries that generous unemployment benefits increase the duration of unemployment spells, but also the duration of subsequent employment spells.

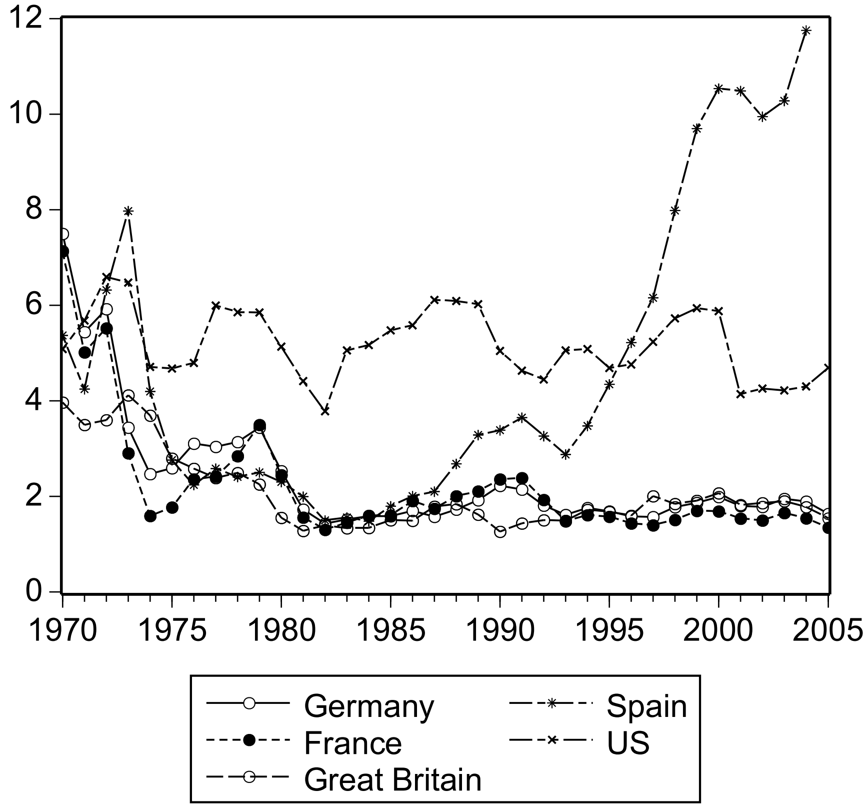
One stylised fact of "European" labour markets that has received much attention is the concurrent rise of both the level and the duration of unemployment since the late 1970s. To illustrate this point, Figure 1.1 depicts the outflow rate from unemployment for France, Germany, Great Britain, Spain, and the US. Noting that the inverse of the outflow rate is a measure for unemployment duration, one can discern the well known fact that one of the main reasons for high and persistent unemployment in France and Germany is long unemployment duration.[25] In all countries bar the US, the duration of unemployment started increasing in the mid-1970s, and rose further in the early 1980s. Only in the US the duration of unemployment did not rise. There, the exit rate from unemployment seems to be driven solely by the business cycle. The picture also conveys an idea of why unemployment has been falling rapidly in Spain since the 1990s, namely the increased exit rate out of unemployment, i.e. the sharp reduction in unemployment duration. This has mainly been attributed to the extensive use of fixed-term contracts.[26] Interestingly, the reduction of unemployment in Great Britain has not coincided with an overall change in unemployment duration. Indeed, as Pissarides (2006) points out, falling unemployment in Great Britain seems to have been mainly due to a change of the way monetary policy was conducted: in 1993, the exchange rate target was abandoned in favour of an inflation target, and in 1997, the Bank of England was given operational independence. Furthermore, the weakening of unions helped to ease inflationary pressure as unemployment fell. Labour market dynamics, however, were relatively unchanged.

The differing performance of the labour markets in European economies on the one hand and the US on the other hand has been analysed extensively using the flow approach to the labour market. The focus has been mainly on the interaction of shocks and institutions. One issue that has

[25] Cf. Machin and Manning (1999).

[26] Cf. Marimon and Zilibotti (1998), and Bentolila and Jimeno (2006) for a detailed account of the evolution of Spanish unemployment. See Blanchard and Jimeno (1995) for an analysis which is more cautionary with respect to the explanatory power of institutions.

Figure 1.1: The outflow rate from unemployment.



attracted particular attention is the impact of an increase in “turbulence” given different institutional settings. Ljungqvist and Sargent (1998, 2004) define turbulence as the probability that an unemployed worker loses his human capital. They argue that this probability has increased during the last three decades. The effect of this evolution in their model differs according to the level of unemployment benefits. In Europe-style welfare state regimes, unemployed workers receive relatively high benefits, which are dependent on previous earnings. When they lose (part of) their human capital during unemployment, their incentive to take up a new job is relatively small, because their expected wage is low when compared with the benefits they receive. Therefore, both the level and the duration of unemployment rise in an economic regime with generous unemployment benefits. In contrast, in regimes with low unemployment benefits, the incentives of unemployed workers to take up a new job are not affected significantly when they lose their human capital. While theoretically appealing, there is very little direct empirical evidence on this type of turbulence. Chapter 4 of this thesis looks at the issue of turbulence, using various definitions.

Another approach to the differing experience between the US and European economies is provided by Marimon and Zilibotti (1999), who follow the literature on mismatch described above. Like Ljungqvist and Sargent (2004), they focus on the interaction of shocks and institutions, which they model as different levels of unemployment benefits. In particular, they analyse how the effect of a shock increasing the degree of mismatch on the labour market depends on the prevailing institutional settings. Their results are similar to Ljungqvist and Sargent (2004), in that a regime with high unemployment benefits reduces the incentives of unemployed workers to take up a new job, while this is not the case with low unemployment benefits. They argue that this explains a large part of the differences between the US and Europe in terms of the level of unemployment and the evolution of wage inequality. As we show in Chapter 2, this result depends strongly on their assumption of exogenous job destruction.

Especially the work by Ljungqvist and Sargent has raised the interest in mismatch, turbulence, and structural change. As noted above, Lucas and Prescott (1974) were among the first to model unemployment as a phenomenon arising from frictions in the economy. In their model, workers move from one "island" to the other in order to maximize their expected wage. As movements between islands are time-consuming, there is frictional unemployment. This framework was extended by Rogerson (1987, 2005) to allow explicitly for a sectoral division of the economy. In Rogerson (2005), workers who leave declining sectors can also end up in non-employment, which does not happen in Lucas and Prescott (1974). Ngai and Pissarides (2005) analyse a multi-sector model of growth with differences in TFP growth rates between sectors and derive conditions for balanced growth in the presence of structural change and sectoral worker reallocation. Structural change has also been analysed empirically. Marimon and Zilibotti (1998) analyse the difference in employment growth between 11 European countries. Decomposing for country, sectoral, and temporal effects, they find that sectoral effects account for 80% of cross-country differences. In particular, they attribute the high Spanish unemployment rate of the 1990s to the difficulties this country had in reallocating employment from agriculture to industry. Kambourov and Manovskii (2004) analyse occupational and sectoral mobility in the US for the time period 1968-1997. They argue that the increase in occupational mobility documented in their paper can be viewed as a measure of turbulence as defined by Ljungqvist and Sargent (1998). Furthermore, this rise can potentially account for a number of labour market phenomena, such as the evolution of wage inequality and the flattening of age-earnings profiles observed in the US. Generally however, there is little research on the role of structural change for labour market dynamics. One of the few papers in this area is Greenaway et al. (2000) who examine the behavior of net and gross worker flows in the UK over the time period 1950-2000. Their key findings are, first, that gross worker flows do not display a secular trend, and second, that net worker flows, i.e. sectoral reallocation, was higher in the 1970s and 1980s than in any other post-war decade. They also argue that gross worker flows are not indicative of the amount of sectoral reallocation occurring. Instead, they are best seen as an indication of the cost of sectoral reallocation.

Finally, the flow approach also has important implications for macroeconomic modelling. One of the issues in this area that has attracted much attention recently is the propagation of productivity shocks implied by labour market imperfections. As Shimer (2005a) has shown, the Mortensen-Pissarides model fails to replicate the volatility of unemployment, and especially of vacancies, observed in the data. Several remedies have been suggested, such as different mechanisms that make the wage more rigid than is the case with Nash bargaining (e.g. Hall, 2005a, Hall and Milgrom, 2005), or a high outside option, together with low bargaining power, of workers (Hagedorn and Manovskii, 2005). These approaches have one common feature, namely the exogeneity of job destruction.[27] This is usually justified by the observation that, in the data, separations are relatively constant over the business cycle (cf. Hall, 2005b). However, I argue below that these approaches rely on a wrong reading of the data.

1.5 German Labour Market Dynamics: A Literature Overview

As described above, the search and matching model has played a very important role for the analysis of various national labour markets. For Germany, however, the use of the flow approach has been very much limited.[28] In the following, I briefly summarize the literature that exists on worker flows on the German labour market.[29]

A comprehensive overview of labour market flows in various European countries, including Germany, is given in Burda and Wyplosz (1994), who establish the main stylised facts for worker flows in these countries. An analysis of German labour market flows using data from the German Socio-Economic Panel (SOEP) for the time period 1983 to 1994 is provided by Schmidt (2000b,a). Schmidt (2000a) is concerned with the cross-sectional and long-run properties of labour market flows, while Schmidt (2000b) examines their cyclical behaviour. The main findings are as follows. First, important cross-sectional differences between demographic groups exist. Second, no important long-run trends can be observed, except for the fact that the job-finding rate declined sharply in the early 1990s. Third, as for the cyclical

[27] See Mortensen and Nágypal (2005) for an exception.

[28] To be sure, there is a large literature analysing the outflows out of unemployment, to employment, which is briefly discussed below. Also, there are studies on transitions to employment after an apprenticeship (e.g. Fitzenberger and Spitz-Oener, 1999). However, there are only very few studies taking into account all labour market transitions from a macroeconomic perspective.

[29] See also Franz (2006), Chapter 9.

properties, demographic groups are shown to differ in their sensitivity to the cycle. These studies, however, suffer from several shortcomings. First, the main deficiency of the SOEP in this context is that it only provides retrospective data with respect to job changes, which is prone to measurement error. Second, the flows between employment and the out-of-the-labour-force status are not considered explicitly in the studies mentioned above, and direct job-to-job transitions are not considered at all.

There are some studies on worker flows and mobility using data on social security employment provided by the Institute for Employment Research (IAB), which is the same data set used in Chapters 3 and 4 of this thesis. Descriptive evidence on worker flows is provided in Bender et al. (1999b) for the time period 1985-95.[30] They analyse the flows between employment and unemployment, as well as direct job-to-job transitions, with a particular focus on occupational mobility. They do not find a significant trend in occupational mobility, and therefore attribute most of this type of mobility to cyclical factors. One exception is the occupational mobility of the unemployed, who became more flexible in this respect during the time period under investigation.

Another aspect of worker flows which has received particular attention in the literature on the U.S. labour market is the importance of recalls (cf., e.g., Anderson and Meyer, 1994). This issue is investigated by Mavromaras and Rudolph (1995, 1998) for the German labour market. They show that temporary layoffs play an important role for employment adjustment, accounting for about 12% of accessions during the time period 1975-1990. Furthermore, recalls are heavily concentrated among certain worker groups and specific firm sizes.

One area of research where search and matching theory has had an impact in Germany is the empirical investigation of the exit rate from unem-

[30] Similar evidence is provided by Schettkat (1996), Erlinghagen (2005), and Fitzenberger and Garloff (2005a). The latter paper also addresses the evolution of wages associated with labour market transitions. Fitzenberger and Garloff (2005b) investigate the link between unemployment and residual wage dispersion, and find evidence that frictions do play an important role for wage determination.

ployment, as well as of matching functions. The flow from unemployment to employment has been analysed in detail by Fitzenberger and Wilke (2004b), who examine the effect of changes in the maximum entitlement period for unemployment benefits of elderly unemployed in Germany during the mid-1980s.[31] They find significant changes in non-employment duration, but no significant changes in unemployment between jobs. They interpret these findings as firms and workers using unemployment benefits as part of early retirement packages. The search effort of workers still looking for a job were, however, not affected. Burda and Wyplosz (1994) estimate matching functions for several OECD countries, including Germany. Fahr and Sunde (2004, 2006b) investigate the efficiency of the matching process between job seekers and vacancy posting firms in West Germany for the time period 1980-1997. One of the main conclusions emanating from their research is the fact that matching functions differ greatly between worker groups and between regions. Also using empirical matching functions, Fahr and Sunde (2006a) analyse the effects of the labour market ("Hartz") reforms which were implemented in Germany between 2003 and 2005. They find that these reforms had the effect of making the labour market more dynamic and speeding up the matching process between the unemployed and vacant jobs.

Using a matched employer-employee data set which covers social security employment in Germany, Bauer et al. (2007) analyse the effects of changes in employment protection legislation on worker flows for the time period 1996 to 2004. In particular, they investigate changes in the threshold scale exempting small establishments from dismissal protection provisions. They do not find significant effects on worker turnover. However, as I show in Chapter 3, separations (which are part of total turnover) can be flat, while the underlying flows change significantly. It would therefore be interesting to investigate composition effects in worker turnover as well.

[31] For a summary of the labour market reforms after 1990, see Wunsch (2005), and Ebbinghaus and Eichhorst (2006). Other studies on unemployment outflows are Fitzenberger and Wilke (2004a), and Steiner (2001).

1.6 Outline of the Thesis

This thesis comprises a theoretical study (Chapter 2) and related empirical work (Chapters 3 and 4). Chapter 2 contains a theoretical investigation of skill mismatch, which is intimately linked to the issues of turbulence and structural change on the labour market. In particular, I analyse the interaction of a shock to skill mismatch with specific institutional settings. I show that the nature of job destruction (endogenous or exogenous) plays a crucial role for the results obtained. Chapter 3 takes this result as a starting point by empirically analysing the behaviour of worker flows, and especially of match separations, in Germany. This is done using a large micro data set which contains individual worker histories. Chapter 4 (which is joint work with Michael C. Burda) empirically explores the issues of turbulence and structural change by analysing occupational and sectoral mobility in West Germany. We show that structural change, namely the reallocation of employment from production to services, strongly accelerated after German reunification, and discuss the resulting dynamics of the labour market. I now briefly describe the three chapters in turn.

The starting point of Chapter 2 is a model that has been proposed by Marimon and Zilibotti (1999) to explain the differing labour market experience of the large European countries mentioned above ("Europe"), and the United States. The basic mechanism of this model is the following: there is *ex ante* heterogeneity in the labour market in that firms have specific skill requirements and workers dispose of specific skills. A worker-firm pair which is characterised by a good fit of skills and skill requirements is more productive than a worker-firm pair which features a bad fit. Given this set-up, two different economic regimes are subjected to the same shock, namely, an increase in the mismatch between firms and workers. In other words, this shock makes it harder for both firms and workers to find a suitable partner in the labour market. In the first economic regime, characterised by low unemployment benefits ("laissez-faire"), the shock has hardly any consequence on the level of unemployment, but increases income inequality. In the second regime, which features higher unemployment benefits ("welfare state"), unemployment rises considerably as the shock strikes. The reason for this is that the incentive to take up a job is greatly reduced for unemployed workers.

The contribution of the second chapter is to introduce a standard ingredient of search and matching models, namely endogenous job destruction in the spirit of Mortensen and Pissarides (1994), into the model. This generates two results. First, the model is able to generate the fact found by Tatsiramos (2006) that higher unemployment benefits lead to more stable post-unemployment matches. Second, the consequences of this modification demonstrate that the effects described above crucially depend on the assumption of exogenous job destruction. Once this assumption is relaxed, the results by Marimon and Zilibotti (1999) break down completely. In particular, an exogenous increase in mismatch does *not* lead to an increase in unemployment in the economy any more. This is due to the fact that a worker who is in a match characterised by low mismatch, will accept temporary wage cuts if the current productivity of the match is low. Therefore, the duration of good matches increases, and unemployment does not rise.

The result of the second chapter, namely that the nature of job destruction (endogenous or exogenous) is crucial for the results obtained in a search and matching model of the labour market, provides the starting point of the third chapter. There, I analyse the behaviour of worker flows, including their cyclical features, in Western Germany. The empirical strategy thus does *not* consist of running cross-country panel regressions. This strategy certainly provided interesting insights when first used (e.g. by Layard et al., 2005, in the first edition of their book) by uncovering hitherto unknown correlations. However, there seems to be very little value added to be gained by elaborating on this exercise. Given that for most countries the time series on unemployment and (especially) worker flows do not go back very far, the number of data points is still relatively limited. Furthermore, as discussed above, the analysis of the impact of institutions is complicated by the fact that there was very little variation in the institutional settings in most countries. Finally, these institutions interact with each other, which raises the number of potentially important explanatory variables. The combination of few data points and many explanatory variables featuring little variation makes robust econometric estimation virtually impossible within a panel of countries.[32] This is the reason why the analysis in Chapter 3 considers micro data from one country only.[33] In particular, I use a very large panel data set on individual workers from Western Germany who are covered by social security legislation in order to examine worker flows.

Chapter 3 starts by presenting stylised facts on worker flows with respect to both their cross-sectional and time-series properties. I then analyse their cyclical features in detail. I find that separations are relatively constant over the cycle, while accessions are much more volatile. As discussed above, this result has played an important role in the search and matching literature for the US labour market (Fallick and Fleischman, 2004, Shimer, 2005a). In contrast to the US literature, I emphasise the fact that this contrasting behaviour of separations and accessions is due to the differences in the underlying flows.[34] In particular, the composition of separations changes markedly over the business cycle: in a recession, flows to unemployment rise, while direct job-to-job transitions fall. This feature should be taken into account in the construction of search and matching models of the labour market. Given these results, and given that different labour market flows imply very different mechanisms, setting separations constant over the business cycle and invoking an exogenous job destruction process might well lead to wrong conclusions.

In addition, Chapter 3 provides an analysis of the dynamics of the flow into unemployment, using a decomposition originally proposed by Nagypál

[32]See Blanchard (2006) and Freeman (2005) for a similar point of view. See, however, Di Tella and MacCulloch (2005) for a recent application of this approach.

[33]To be sure, Chapter 3 does not explicitly analyze the impact of institutions, but instead focus on the cyclical features of worker flows. For an explicit analysis of institutions, see Bauer et al. (2007), and Hunt (1999).

[34]The separation flows considered are the ones going from employment to another job, to unemployment, or to non-participation, the accession flows are all flows leading to a new match.

(2004). I show that the reason for a worker becoming unemployed during a recession is not an increase in separations, but the fact that upon separation, he is less likely to have a job lined up during a recession than during a boom. Therefore, I confirm the evidence from the U.S. labour market for the German labour market that a crucial factor for the increase in the flow from employment to unemployment during a downturn is the hiring behaviour of firms.

In Chapter 4 (which is joint work with Michael C. Burda), we empirically investigate the issue of structural change, mismatch, and turbulence, which was dealt with in a theoretical framework in Chapter 2. We start out by documenting a fact which seems to have gone unnoticed in the literature on the development of the German labour market: the pace of structural change in the West German economy strongly accelerated after 1990, which was mainly due to the fact that the manufacturing sector started shrinking more quickly than during the previous decade. This evolution went together with an strong increase in "turbulence" as measured by a number of indicators. In order to analyse the dynamics of structural change in more detail, we calculate worker flows from a panel data set covering 2% of the German social security workforce for the time period 1975-2001. In contrast to the increase in *net* worker flows (i.e. worker flows having a net impact on sectoral employment stocks), we find that *gross* worker flows did not display a marked long-run trend, although there are indications of higher gross worker flows in the second half of the 1990s. In other words, the net sectoral "yield" from gross workers flows (or churning) temporarily increased after 1990. Net worker flows are therefore investigated in more detail. We find that job-to-job flows only play a minor role for net employment changes, with transitions between employment and unemployment coming second, and flows between employment and non-registration playing the most important role. However, net flows vary significantly between sectors, which can be seen by comparing a strongly shrinking sector (consumer goods) with a quickly growing sector (business-related services). We document that, for the shrinking sector, net employment adjustment mainly came about by lower accession rates, not higher outflow rates. Conversely, growing sectors seem to increase because more workers enter these sectors, not because less people leave. Growing and shrinking sectors also rely on different transitions for employment adjustment. While for the growing sector, hirings from non-registration were most important, shrinking sectors mainly release workers into unemployment. Finally, Chapter 4 investigates the behaviour of net and gross flows over the business cycle. Net reallocation is found to be counter-cyclical, and gross reallocation to be pro-cyclical. We interpret this as an indication of both a sullying and a cleansing effect of recessions: job-to-job transitions involving a change of sector go down sharply; at the same time, workers have to change sector, which leads to rising net reallocation.

Chapter 5, finally, summarises the main results of this thesis, and provides an outlook on future directions of research.

Chapter 2

Skill Mismatch in Equilibrium Unemployment

This paper analyses the effect of skill mismatch in a search and matching model of the labour market. The fact that the model features both two-sided ex-ante heterogeneity and endogenous job destruction has important consequences for the basic workings of the model, and for the effects of labour market policies such as employment protection and unemployment benefits. With endogenous job destruction, labour market policies alter not only the duration of unemployment, but also the duration of employment spells. In particular, matches characterised by high mismatch get quickly destroyed and the distribution of matches is shifted towards more stable employment relationships. This is also the reason why, within this modelling framework, an increase in within-group skill mismatch cannot explain the rise in unemployment in Europe relative to the US. This result stands at odds with previous findings in the literature. Generally, it is argued that in search models with fixed match characteristics, job destruction should be endogenised in order to take account of heterogeneous decision rules.

High and persistent unemployment in many European countries has attracted much attention in the economic literature, especially when contrasted with much lower levels of unemployment in the US.[1] The early research on this topic focussed either on the direct impact of unfavourable shocks, or on changes in labour market institutions.[2] Neither of these two explanations has proved very successful by itself. On the one hand, it is unlikely that the initial shocks of a slowdown in productivity and of an upsurge in oil prices can still be felt nowadays. On the other hand, cross-country regressions focussing on the impact of institutions (e.g. Nickell, 1997) can explain a large share of differences in the levels of unemployment between countries, but they are unable to account for changes in unemployment over time. This is mainly due to the fact that labour market institutions in many European countries have not changed significantly over the time period considered. Therefore, the analysis of the interaction between shocks and institutions has gained centre stage as an explanation for the rise and the persistence of unemployment in many European countries.

One particular shock that has received much attention in this context recently is the increase in mismatch that has occurred over the last three decades in many European countries.[3] Mismatch in this case is defined as the increased difficulties faced by both workers and firms to find a suitable match in the labour market. An indication for this is the outward shift of the Beveridge Curve in many European countries. There is also evidence from the earnings and income inequality literature that mismatch on the labour

[1] For overviews of the literature, see Mortensen and Pissarides (1999a) and Blanchard (2006).

[2] As for the first strand of this literature, Maddison (1987) documents different shocks, such as the slowdown in total factor productivity and the oil price hikes. The impact of these shocks in different economies is examined by Bruno and Sachs (1985). Labour market institutions at the centre of attention were institutions of collective bargaining (cf. Blanchard and Summers, 1986, and Lindbeck and Snower, 1986), or unemployment benefits (Burda, 1988).

[3] Other explanations that have been analysed in this context include the slowdown in total factor productivity (Blanchard and Wolfers, 2000), an increase in turbulence (Ljungqvist and Sargent, 1998, 2004), and skill-biased technological change (Mortensen and Pissarides, 1999c).

market affects workers and firms within narrowly defined groups. These issues can be analysed in a model featuring within-group skill mismatch, as in Marimon and Zilibotti (1999). Their model is characterised by two-sided *ex ante* heterogeneity, i.e. firms have specific skill requirements, which are endogenous, and workers feature exogenously given specific skills. Matches with high idiosyncratic mismatch, i.e. a large difference between the worker's skills and the firm's skill requirements, have low productivity. An increase in mismatch is modelled as an increase in the importance of skill differences in the production function. In order to explain the difference between the US and European economies in terms of unemployment rates, Marimon and Zilibotti (1999) focus on the interaction between a shock which increases the importance of skill mismatch in the production function, and unemployment benefits. They find that with high unemployment benefits, the effect of such a shock is to raise the unemployment rate, but also the productivity per employed worker. With low unemployment benefits, this shock leaves the unemployment rate and productivity unchanged, but wage inequality increases. These results come about because of two distinct roles played by unemployment benefits. On the one hand, unemployment benefits increase the value of unemployment, thus reducing the incentive to take up a job. This *disincentive effect* reduces unemployment outflows and unambiguously leads to a higher level of unemployment. On the other hand, unemployment benefits act as a *search subsidy*.[4] This means that, with higher unemployment benefits, workers spend more time searching for a good (low-mismatch) job, as the opportunity cost of doing so is lower. As a result, worker flows out of unemployment into “bad" jobs (those with high skill mismatch) fall relative to flows into good jobs, and the distribution of jobs is shifted towards good jobs. This, in turn, potentially increases the value of a vacancy, and more firms enter the labour market. Therefore, overall outflows from unemployment can rise, which has the potential to reduce the unemployment rate. Which effect ultimately prevails, and hence the ultimate impact of unemployment

[4]The classic reference for this in a partial equilibrium context is Burdett (1979).

benefits on the level of unemployment, is not clear *a priori*. In the simulation by Marimon and Zilibotti (1999), however, an increase in unemployment benefits unambiguously raises the unemployment rate.

The empirical literature has found support for both the disincentive and the search subsidy effect of unemployment benefits.[5] However, it should be pointed out that the search subsidy effect does not only lead to a higher quality of matches in terms of wages, but also in terms of employment stability.[6] As Marimon and Zilibotti (1999) assume exogenous job destruction, they fail to take this into account. This observation is the starting point of the present paper. In order to consider the effect labour market policies have on the duration of employment spells, I use the modelling framework of Marimon and Zilibotti (1999) and endogenise the job destruction decision in the spirit of Mortensen and Pissarides (1994). The analysis of a model featuring both *ex ante* heterogeneous agents and endogenous job destruction leads to several new insights.

First of all, endogenising the job destruction decision fundamentally alters the basic workings of the model. This is due to the fact that matches characterised by high mismatch are much more quickly destroyed than matches characterised by low mismatch. Therefore, the distribution of matches is shifted towards the latter. Second, a richer analysis of the role of unemployment benefits is possible.[7] As in Marimon and Zilibotti (1999), the latter act as a subsidy to search, which implies job rejection of "bad" matches

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[5] In their seminal paper, Ehrenberg and Oaxaca (1976) find a positive effect of unemployment benefits on post-unemployment wages for the US labour market. Addison and Blackburn (2000) provide a review of the literature which suggests a weak effect of unemployment benefits on post-unemployment wages. Meyer (1990) finds that the exit rate out of unemployment increases the closer workers get to the time of benefit exhaustion.

[6] Tatsiramos (2006) shows for six European countries that generous unemployment benefits increase the duration of unemployment spells, but also the duration of subsequent employment spells. Centeno and Novo (2006) find that, in the U.S., more generous unemployment insurance increases expected tenure, reducing the mass of the lower tail of match duration and increasing the duration of matches available.

[7] Note that this is a model with risk-neutral agents, where there is no need for insurance. An analysis of the role of unemployment benefits as an insurance mechanism in a search model with *ex ante* heterogeneity and risk-averse agents can be found in Acemoglu and Shimer (1999).

and thus increases both unemployment duration and average match quality. With endogenous job destruction, there is an additional effect: the duration of employment spells also rises. This is a direct consequence of improved match quality, as better matches get destroyed less frequently. Third, the effects of job protection legislation along the lines of Mortensen and Pissarides (1999a) can be analysed. Firing costs unambiguously reduce job creation and job destruction in the search model with *ex ante* homogeneous workers by lowering the reservation productivity. The effect on the level of unemployment, however, is not clear-cut. In the model with skill mismatch, an additional factor to consider is *match quality*. Because job destruction is endogenous, firing costs increase the expected duration of a match. At the time the two partners to a match take the decision whether to form the match, the extent of skill mismatch is known. As the latter is fixed over the lifetime of the match, matches with a high skill mismatch are more likely to be rejected with higher firing costs. This means again that firing costs tend to lead to a lower fraction of "bad" matches in the economy, while the effect on unemployment is not clear *a priori*. Finally, as for the effects of an increase in the importance of mismatch in the economy, I find that endogenising job destruction completely changes the results, compared to a model with exogenous job destruction. More specifically, a shock to mismatch does not lead to an increase in unemployment any more, because the increase in the duration of good matches outweighs the lower expected productivity of future matches. Therefore, I argue that an increase in skill mismatch cannot explain the rise in unemployment in Europe relative to the US, while it can explain other important labour market phenomena, such as higher employment and unemployment spells in Europe. From a theoretical perspective, these results show that the heterogeneity of agents should be taken into account also with respect to the job destruction decision. Not doing so could imply that important effects that arise in the interaction of shocks and institutions are neglected.

The plan of the paper is as follows: the next two sections discuss the empirical and theoretical literature linking the rise of European unemployment to mismatch. In Section 2.3, I describe the modelling framework. The key ingredients are specific skill requirements by firms and specific skills by workers, and search frictions which are captured by a matching function. I then show that, given the assumptions of the model, two-sided *ex-ante* heterogeneity is equivalent to *ex-post* heterogeneity. In Section 2.4, the model is simulated. First, I simulate the baseline model. This reveals important differences to a model without endogenous job destruction. I also examine the impact of the replacement rate and of firing costs, especially on the level of unemployment. Second, I subject three different economic regimes, a *laissez-faire* state and two types of welfare state (both featuring positive levels of unemployment benefits, and one featuring additional firing costs), to a shock to aggregate skill mismatch. This is done in order to examine how this shock, given endogenous job destruction, interacts with labour market institutions. The final section summarises the main findings and concludes.

2.1 Empirical Perspectives on Mismatch

The empirical literature on aggregate labour markets has for some time not only been looking at the level of unemployment, but also at the role of worker flows (cf. Burda and Wyplosz, 1994 for a seminal article). For the time period starting in the early 1960s and ending in the late 1990s, the quarterly data from five OECD countries on the stock of unemployment, as well as on worker flows into and out of unemployment feature the following stylised facts:[8] first, while unemployment in the US remained at a (relatively) constant level - roughly 5-6% - , it has increased dramatically in continental European economies - from about 2-3% to over 10% in France and Germany, for example. Second, worker flows into and out of unemployment, normalised by the labour force, do not show a clear trend in the US with a mean of about

[8] Cf. Bachmann (2003) for details. The countries considered are France, Germany, Spain, the UK, and the US.

7%, while they increased in Europe, e.g. roughly doubling in France and in Germany from about 2% to 4%. Nevertheless, they remained way below the US figures at the end of the 1990s. The same features are true for the unemployment inflow rate (defined as unemployment inflows divided by the number of employed workers). Finally, over the time period considered, the outflow rate (outflows from unemployment divided by the stock of unemployment) was relatively constant in the US - fluctuating between 1 and 1.5 - , but was reduced to about 1/4 of its starting value in Europe - from around 1.5-2 to under 0.5 in France and Germany. This implies a quadrupling of the duration of unemployment.

Apart from the level of unemployment and worker flows in the labour market, recent labour market research has focussed on the evolution of earnings and income inequality. As for the former, several stylised facts emerge (cf. Gottschalk and Smeeding, 1997): Looking at the levels of earnings inequality in different industrialised countries at the end of the 1980s, the US, Canada, and the UK stand out as the countries with the highest figures. Germany and the Netherlands stand at the other side of the spectrum. As for the evolution of earnings inequality from the mid-1970s to the mid-1990s, there was a large increase in the US. This was partly due to strongly growing returns to education during the 1980s, and to a milder increase in the returns to experience. However, there was also a large rise in wage dispersion even within education and experience groups.[9] The picture for other industrialised countries is mixed. On the one hand, the UK and Canada experienced a strong increase in earnings inequality, both between and within skill groups. Germany and Italy do not show any signs of increased earnings inequality until the late 1980s. Finally, France features some modest growth in earnings inequality, which mainly seems to be due to between-group effects. Aghion et al. (2002) argue that the rise in the return to permanent components of

[9]Recently, there has been some debate about the evolution of within-group wage inequality in the US (cf. Lemieux, 2006, and Autor et al., 2005). However, this concerns mainly the evolution of wage inequality since the mid-1990s. As the model presented here is concerned with the comparison of wages and unemployment between the early 1970s and the early 1990s, it is not affected.

individual skills accounts for between half and two thirds of the increase in inequality in the US. The remaining part is attributable to the transitory components of earnings. The latter is influenced by the diffusion of new technologies, which increase the importance of stochastic factors. This in turn raises the premium to workers with no observable distinguishing characteristics other than their "good fortune". In other words, within-group inequality rises with technological progress. This evidence on within-group inequality is one of the motivations of the set-up of the model by Marimon and Zilibotti (1999). Another empirical feature of labour markets in the OECD has been an instability of the Beveridge Curve (cf. Nickell et al., 2003). In the US, the Beveridge Curve shifted outwards in the 1970s. However, this move was undone by a later backward shift, which brought the ratio of vacancies to unemployment virtually back to where it had been. Thus, the location of the Beveridge Curve was nearly the same in the 1960s and the late 1990s. In most of the large European economies, namely France, Germany, and Spain, however, the outward shift of the Beveridge Curve was not undone. This is an indication that mismatch on the labour market increased between the 1960s and the 1990s. As pointed out by Layard et al. (2005), this outward shift of the Beveridge Curve occurred in all sectors of the economy to a roughly equal extent.

2.2 Mismatch from a Theoretical Perspective

The main theoretical explanations discussed in the literature for differences in unemployment levels between the US and Europe are different shocks, different institutions, and an interaction between shocks and institutions. However, there is little evidence for macroeconomic shocks having differed between the US and Europe. Furthermore, the institutional set-up in those two regions has not changed significantly during the last few decades, while their economic (and labour market) performance has: the continental European countries, which are currently facing much higher levels of unemployment than the US does, featured much lower levels of unemployment than the US before the 1970s. Therefore, merely taking differences in institutions as an explanation is not satisfactory either, as those same institutions produced very different labour market experiences over the course of the second half of the last century. An interaction between shocks and institutions thus seems to be the most convincing explanation. For example, Blanchard and Wolfers (2000) find significant empirical evidence for this explanation in a panel of countries.

The interaction between shocks and institutions is also the key mechanism featuring in the model by Marimon and Zilibotti (1999). In their model, there is two-sided *ex ante* heterogeneity, i.e. firms have specific skill requirements, which are endogenous, and workers feature exogenously given specific skills. An increase in mismatch is modelled as an increase in the importance of skill differences in the production function. Here the intuition is that faster technological progress leads to changing requirements by the firm, which the worker might be able to fulfill only partly. One can also think about this in terms of the economy becoming more complex, i.e. the "variety" of skill requirements by firms increases. This happens in the economy as a whole, which implies that all firms and workers are affected symmetrically. This intuition is in line with the fact that the outward shift in the Beveridge Curve mentioned above occurred across all sectors by a comparable amount (cf. Layard et al., 2005, p. 326). An aggregate technological shock therefore increases the degree of mismatch in the entire economy. Marimon and Zilibotti (1999) contrast two economies: one with high unemployment insurance ("Europe"), the other one with low unemployment insurance ("US"). An increase in skill mismatch doubles unemployment in the European economy. In the *laissez-faire* US economy, unemployment stays roughly constant, but wage inequality increases more and overall productivity grows less than in European economies. Unemployment benefits play two distinct roles. On the one hand, they increase the value of unemployment, thus reducing the incentive to take up a job. This *disincentive effect* reduces unemployment outflows and unambiguously leads to a higher level of unemployment. On the other hand, unemployment benefits act as a *search subsidy*. This means that, with higher unemployment benefits, workers spend more time searching for a good (low-mismatch) job, as the opportunity cost of doing so is lower. As a result, worker flows out of unemployment into "bad" jobs (those with high skill mismatch) fall relative to flows into good jobs, and the distribution of jobs is shifted towards good jobs. This, in turn, potentially increases the value of a vacancy, and more firms enter the labour market. Therefore, overall outflows from unemployment can rise, which has the potential to reduce the unemployment rate. Which effect prevails, and hence the ultimate impact of unemployment benefits on the level of unemployment, is not clear *a priori*. In their calibration, however, unemployment rises unambiguously.

An increase in *turbulence* in combination with a generous welfare state is seen by Ljungqvist and Sargent (1998, 2004) as an important factor that has raised unemployment in many European economies. In their reply to Den Haan et al. (2001), Ljungqvist and Sargent (2004) introduce human capital into an otherwise standard matching model of unemployment. While on the job, workers accumulate human capital. When unemployed, however, workers face a certain probability of losing their human capital. An increase in this probability is called an increase in "turbulence". Given differences in institutions (modelled as different levels of unemployment benefits), an increase in turbulence can have very different implications. High unemployment benefits (the "European" regime) in combination with an increase in turbulence lead to high unemployment and low exit rates from unemployment. An increase in turbulence given low unemployment benefits (the "US" regime) in contrast has negligible effects. Thus, the effect of a specific shock depends on the institutional features of the economy affected. However, this model has several shortcomings. First, it does not replicate the increase in unemployment inflows observed in Europe. Second, the rise in European unemployment and the fall of the unemployment outflow rate is attributed to highly skilled workers. This does not correspond to the empirical evidence

(Cf. Mortensen and Pissarides, 1999a). Finally, job destruction is taken to be exogenous. It has been shown that endogenising the job destruction decision can significantly alter the results.[10,11]

Another strand of the literature related to the analysis presented here consists of models which feature *skill biased technological change*. As in my model, Mortensen and Pissarides (1999c) assume that worker skills are exogenously given and that firms endogenously choose their skill requirements. However, workers' skills and firms skill requirements range from low skills to high skills. The workers with a specific skill level can perform jobs requiring lower skills, but they can not work on jobs requiring higher skills. Job destruction is endogenous. The key difference to my model is that the aggregate labour market is fully segmented by skill into sub-markets characterised by separate matching functions. This in turn implies that differences between workers of identical type only arise from idiosyncratic shocks. Therefore, one of the key elements of my model, a permanent match-specific component yielding within-group differences, is not present.

The model by Albrecht and Vroman (2002) is close to Mortensen and Pissarides (1999c). There are several important differences though: first, in the former model, the labour market is not necessarily segmented. Furthermore, there are only two types of jobs and workers, high-skill and low-skill. Finally, job destruction is exogenous. Compared to the model presented here, the latter two characteristics are the most important differences. I am able to analyse a large number of agents, and, by allowing for endogenous job destruction, I explicitly take into account that jobs featuring a permanent high-productivity component have a lower probability of getting destroyed.

The next section describes in detail the model used in the present paper.

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[10]Cf. Haefke (1999).

[11]It should also be pointed out that the simulation exercise by Ljungqvist and Sargent suggests a scenario that is different from the stylised facts even with respect to the level of unemployment. As pointed out above, European unemployment was way below the US figures in the 1970s.

2.3 The Model

2.3.1 Ex-ante Heterogeneity, Production, and Search Frictions

There is a continuum of infinitely lived workers with mass normalised to one. Workers are heterogeneous in the sense that they are characterised by idiosyncratic types of human capital, or “skills". These skills, denoted by sw, are uniformly distributed on a circle and are fixed forever. No ranking of skills (“high", “low", etc.) whatsoever is implied. The only important feature in this context is the *specificity* of human capital - which is the appropriate concept because the focus here is on within-group effects. This is also the reason for the circular setup which can best be understood when contrasted with a linear setup. Imagine worker skills were distributed uniformly on a line of finite length. Then a worker located at one of the extreme ends of the line has very different expectations about the distribution of firms relative to his position than a worker located in the middle of the line. This is true for most firm distributions, and in particular for the uniform distribution. The situation is very different in the case of a circle. Here, two workers located at different points of the circle have the same expectations about their distance to firms on the circle, given that the latter are distributed uniformly (I show below that this is the case in my model). The circular setup is therefore chosen for two reasons: first, it yields identical expectations among heterogeneous workers. This goes along well with my focus on within-group differences. Second, as turns out below, some of the computations can be dramatically simplified. As for workers' states, they can be either employed or unemployed. There is no on-the-job search. In the former case they receive a net wage of $(1-\tau)\cdot w(\cdot)$, in the latter case they receive an unemployment benefit $(1-\tau)\cdot b(\cdot)$. The government levies the wage tax in order to finance the unemployment benefit. The tax on unemployment benefits is introduced for technical reasons. Rocheteau (1999) argues that a balanced-budget rule for setting taxes can give rise to a multiplicity of equilibria, because firms do not take into account the externality they are exerting on the government budget, and hence on tax rates, when they open up a vacancy. High taxes can therefore lead to low recruiting effort by firms, which results in high unemployment. This effect does not materialize here because unemployed workers are paid unemployment benefits net of taxes. As shown in section 2.3.3, tax rates do not enter the wage, and therefore they do not feature in the expected gain from opening up a vacancy either.

The mass of firms in the economy is endogenously determined. Vacancies incur a flow cost c. Each firm has a specific skill requirement, sf, which is located on the same circle as worker skills. Firms can employ one worker at the most. The production of a worker-firm match takes place according to a linear production function, which consists of two factors: an idiosyncratic productivity parameter, x, which is stochastic, and a measure of the mismatch between the worker skill, sw, and the skill requirement of the firm, sw. Skill mismatch is defined as the distance on the circle between the skill parameters of the two parties, $\delta \equiv |sf - sw|$. Output at a given moment in time is assumed to be determined as follows:

$$\phi(x, sf, sw) = max(\eta + x, \eta + x + a \cdot (1 - \gamma \cdot \delta))$$

Idiosyncratic productivity x is drawn from a distribution $F(x)$ with support in the range $0 \leq x \leq 1$. Draws are taken from the distribution at Poisson rate λ. The parameter a indicates how important skill mismatch is for productivity. More specifically, a rise in a increases the weight of skill mismatch in the production function. This is meant to capture the stylised fact of an outward shift of the Beveridge curve, which is equivalent to an increase in mismatch. As a is assumed to be positive, minimal (i.e. zero) mismatch yields maximal output. The parameter η is a positive shift parameter that is used in the calibration exercise, and γ is a positive scale parameter.

Job destruction is endogenous. The decision whether a job is destroyed is taken each time a shock to productivity arrives. A firm that destroys a match has to pay a firing cost T. As shown below, just as in the standard search model of equilibrium unemployment there will be a reservation productivity level, where the parties to the match are just indifferent between continuing production and separating. Denoting with $J(\cdot)$ the value of an existing job to the firm, this level is given by the condition $J(\cdot) + T = 0$.

The labour market displays frictions which are captured by a matching function, $m(u, v)$, where u and v denote the mass of unemployed workers and of vacancies, respectively. Search is undirected. Furthermore, there are no informational asymmetries, which means that when a firm and a worker meet, both know their own and their partner's type. Following standard notation[12], I define the rate at which vacant jobs become filled as $q(\theta) \equiv m(\frac{u}{v}, 1)$, where $\theta \equiv \frac{v}{u}$ is the tightness of the labour market. The frictions on the labour market derive, e.g., from information imperfections about potential trading partners, the absence of perfect insurance markets, slow mobility, and congestion from large numbers. The matching function features the standard assumptions of concavity and homogeneity of degree one.

2.3.2 The Value Functions

Given the above environment, the lifetime of a firm is as follows (see also Figure A.1 in the appendix): a firm decides to enter the labour market and therefore creates a vacancy of type sf at a cost. With probability $q(\theta_{sf})$, the firm meets an unemployed worker. Worker skills in this case are distributed according to a distribution function $G_1(sw)$. If the match is profitable for the values x and δ, the worker is hired, i.e. a match is formed, the firm will start production, and a wage $w^o(x, \delta)$ is paid to the worker. Otherwise, the match is not concluded, the firm is destroyed, and the worker remains unemployed. Note that in this case, no firing costs have to be paid. For productive matches, shocks to idiosyncratic productivity x arrive with Poisson rate λ. Every time a shock to idiosyncratic productivity x arrives, the profitability of the match changes and the stop production/continue production decision has to be taken anew. The mismatch parameter δ is fixed over the lifetime of the

[12] Cf. Petrongolo and Pissarides (2001).

match. Because of firing costs the threat points of the partners to a bargain differ depending on whether the match has been newly formed or whether it is a continuing match. In the former case, firing costs do not enter the wage bargain. In the latter, they do. Following Pissarides (2000), I therefore introduce a two-tier wage structure. This also implies two values for the job to a firm, and two values for the job to a worker. The outside value of a job, J^o, the inside value of a job, J, and the value of a vacancy, V, are therefore:[13]

$$\begin{aligned}
rJ^o_{sf}(x,sw) &= \varphi(x,sf,sw) - w^o(x,sf,sw) \\
&\quad +\lambda \int_0^1 max\{J_{sf}(x',sw), V_{sf} - T\} dF(x') \\
&\quad -\lambda J^o_{sf}(x,sw) && (2.1) \\
rJ_{sf}(x,sw) &= \varphi(x,sf,sw) - w(x,sf,sw) \\
&\quad +\lambda \int_0^1 max\{J_{sf}(x',sw), V_{sf} - T\} dF(x') \\
&\quad -\lambda J_{sf}(x,sw) && (2.2) \\
rV_{sf} &= -c + \frac{m(u,v_{sf})}{v_{sf}} \cdot \\
&\quad \int_0^1 \int_0^1 max\{J^o_{sf}(x',sw') - V_{sf}, 0\} dF(x') dG_1(sw') && (2.3)
\end{aligned}$$

where x' and sw' denote new values of x and sw, T is the firing tax, and where the "$.^o$"-superscript denotes an outside wage/value, i.e. the wage/value that applies to a match that has been newly formed.

Workers can be in either of two states: employment or unemployment. When employed, workers receive a wage $(1-\tau)\cdot w$. As in the case of the firms, Poisson arrival rates determine the probability of changes in idiosyncratic productivity x. The type of skill requirement a worker encounters in a new match is drawn from the distribution function $G_2(sf)$. For a given worker skill, the flow value of working in a filled (outside) job, W (W^o), and of unemployment, U, are:

[13] The derivations of the value functions are described in Appendices A.2.4 and A.2.4.

$$
\begin{aligned}
rW^o_{sw}(x,sf) &= (1-\tau)\cdot w^o(x,sf,sw) \\
&\quad +\lambda\int_0^1 max(W_{sw}(x',sf),U_{sw})dF(x') - \lambda W^o_{sw}(x,sf) \quad (2.4)\\
rW_{sw}(x,sf) &= (1-\tau)\cdot w(x,sf,sw) + \lambda\int_0^1 max(W_{sw}(x',sf),U_{sw})dF(x') \\
&\quad -\lambda W_{sw}(x,sf) \quad (2.5)\\
rU_{sw} &= (1-\tau)\cdot b + \frac{m(u_{sw},v)}{v_{sw}} \\
&\quad \times\int_0^1\int_0^1 max\{W^o_{sw}(x',sf')-U_{sw},0\}dF(x')dG_2(sf') \quad (2.6)
\end{aligned}
$$

where x' and sf' denote new values of x and sf, respectively.

2.3.3 Equilibrium

Overall equilibrium is attained through the agents' maximisation problems, a wage-setting rule, a free-entry condition in the market for vacancies, inflows into unemployment equalling outflows from unemployment in the labour market, and a balanced government budget. I first prove that wages and value functions are independent of "absolute" skill type, and then show what this implies for the optimising behaviour of workers and firms. Finally, I state the equilibrium conditions of the economy.

Wages and value functions

Free entry into the market for vacancies implies that the value of a vacancy is zero in equilibrium, i.e. $V_{sf} = 0$. The following lemma shows that firms with different skill requirements have the same probability of matching with a worker.

Lemma 1. *Let the matching function be characterised by homogeneity of degree one, and let the distribution of unemployment be identical across skill types. Then, the matching probability is the same across vacancy types.*

Proof. Given the above assumptions, with $V_{sf} = 0$ it follows from (2.3):

$$\begin{aligned}
\frac{c \cdot v_{sf}}{m(u, v_{sf})} &= \int_0^1 \int_0^1 max\{J^o_{sf}(x', sw'), 0\} dF(x') dG_1(sw') \\
\frac{c}{m(\frac{u}{v_{sf}}, 1)} &= \int_0^1 \int_0^1 max\{J^o_{sf}(x', sw'), 0\} dF(x') dG_1(sw') \\
\frac{c}{q(\theta_{sf})} &= \int_0^1 \int_0^1 max\{J^o_{sf}(x', sw'), 0\} dF(x') dG_1(sw')
\end{aligned}$$

where I have used the definition of the matching function and its property of homogeneity of degree one. With an identical distribution of unemployment across skill types, the right-hand side, the expected value of a job of skill requirement sf, is the same across skill requirements, therefore:

$$q(\theta_{sf}) = q(\theta_{\tilde{sf}}) \qquad \forall sf, \tilde{sf}$$

$\square$

Given Lemma 1, one can define a common market tightness for all matches as $\frac{v_{sf}}{u} \equiv \theta_{sf}$. It should be noted that this is not the same as overall market tightness, which is given by $\theta \equiv \int_0^1 \theta_{sf} dG_2(sf)$.

The next corollary is an immediate consequence of identical matching probabilities.

Corollary 1. *Firms will open their vacancies in such a way that they are spread evenly across the circle of skill requirements.*

Proof. By contradiction. Suppose that the distribution of vacancies is uneven. Then, the matching probability of a vacancy is higher where the mass of vacancies is lower, which is a contradiction to Lemma 1. $\square$

It therefore follows from the value function for vacancies:

$$\frac{c}{q(\theta)} = \int_0^1 \int_0^1 max\{J^o(x', sw'), 0\} dF(x') dG_1(sw') \tag{2.7}$$

Equation (2.7) tells us that the expected costs from opening a vacancy will equal the expected benefits, given the firm's type and the firm's expectations about the distribution of worker types.

Wages are determined in a Nash bargain, i.e. the parties to the match choose the wage such as to maximise the joint match surplus. Because of the existence of firing costs, I distinguish between an inside and an outside value of the surplus:

$$
\begin{aligned}
S^0(x, sf, sw) &\equiv W^0_{sw}(x, sf) + J^0_{sf}(x, sw) - U_{sw} \\
S(x, sf, sw) &\equiv W_{sw}(x, sf) + J_{sf}(x, sw) + T - U_{sw}
\end{aligned}
$$

where I have already used the fact that $V_{sf} = 0$ in equilibrium. Inside and outside wages therefore satisfy the following conditions:

$$
\begin{aligned}
w^o(x, sf, sw) &= \arg\max(W^o_{sw}(x, sf) - U_{sw})^{\beta}(J^o_{sf}(x, sw))^{(1-\beta)} \\
w(x, sf, sw) &= \arg\max(W_{sw}(x, sf) - U_{sw})^{\beta}(J_{sf}(x, sw) + T)^{(1-\beta)}
\end{aligned}
$$

with β being the bargaining power of the worker. The first-order conditions for a match with worker's skill sw and firm's skill requirements sf are therefore

$$(1-\tau)\beta(J^o_{sf}(x, sw)) = (1-\beta)(W^o_{sw}(x, sf) - U_{sw}) \tag{2.8}$$

$$(1-\tau)\beta(J_{sf}(x, sw) + T) = (1-\beta)(W_{sw}(x, sf) - U_{sw}) \tag{2.9}$$

In the appendix, I show that the outside and inside wages can be expressed as follows:

$$w^o(x, sf, sw) = (1-\beta)b + \beta[\varphi(x, sf, sw) + \theta c - \lambda T] \tag{2.10}$$

$$w(x, sf, sw) = (1-\beta)b + \beta(\varphi(x, sf, sw) + \theta c + rT) \tag{2.11}$$

As in the standard search and matching model, wages depend positively on productivity, market tightness, and creation costs. Furthermore, the firing costs have a negative impact on outside wages, but a positive impact on inside wages. The reason for this feature is that in the latter case the costs are sunk, and therefore enter the Nash bargain to the detriment of the firm. It is also worth noting that the tax rate does not enter the expressions for wages, the reason being that unemployment benefits are taxed as well. As explained in section 2.3.1, this implies that one does not have to worry about the existence of multiple equilibria. I now show that wages only depend upon idiosyncratic productivity x and mismatch δ.

Lemma 2. *In equilibrium, wages are independent of "absolute" skill type in the sense that the skill type enters wages only through the distance function* $\delta = |sf - sw|$*, i.e.* $w(x, sf, sw) = w(x, \delta)$*.*

Proof. This follows immediately from equations (2.10) and (2.11), the fact that production depends only upon δ, and the fact that market tightness is independent of skills (Corollary 1). □

The next lemma shows that in this model, one can replace the distribution functions $G_1(sw)$ and $G_2(sf)$ by a common distribution function for δ, $G(\delta)$. This result is due to the assumption of undirected search, and the fact that both workers' skills and firms' skill requirements are uniformly distributed along a circle.

Lemma 3. *Given undirected search by firms and workers, one can replace* $G_1(sw)$ *and* $G_2(sf)$ *by* $G(\delta)$ *such that*

$$\int_0^1 \int_0^1 \int_0^1 \varphi(x, sf, sw) dF(x) dG_1(sw) dG_2(sf) = \int_0^1 \int_0^1 \varphi(x, \delta) dF(x) dG(\delta).$$

Proof. See Appendix A.2.4. □

Using this lemma, the next theorem shows that the value functions do not depend on absolute skill type either.

Theorem 1. *In equilibrium, the value functions depend on* δ *and* x *only.*

Proof. This follows from the fact that market tightness, and hence matching probabilities, are independent of skills (Corollary 1), and the facts that production and wages depend on δ and x only (definition of the production function, and Lemma 2). □

As a consequence of Theorem 1 and of Lemma 3, sf and sw can be dropped from the expressions for V and U, and replaced sf and sw in the expressions for the other value functions and for the wages with δ.

Corollary 2. *The value functions for unemployment and for vacancies are independent of absolute skills and absolute skill requirements, i.e.* $U_{sw} = U$, $V_{sf} = V$.

Corollary 3. *The value functions for a firm's filled job and for a worker being employed are independent of absolute skills and absolute skill requirements, i.e.* $J_{sf}(x, sw) = J(x, \delta)$, $W_{sw}(x, sf) = W(x, \delta)$.

The above results imply that the type of two-sided *ex ante*-heterogeneity present in this model can be conveniently reformulated as *ex ante*-homogeneity by means of a variable which has an impact on *ex post*-heterogeneity. In other words, heterogeneity among matches only arises after a match has been formed, and it stems from two sources: skill mismatch, represented by the variable δ, which is fixed over the lifetime of the match, and idiosyncratic productivity x, which is subject to stochastic shocks.

Optimal stopping

It is now possible show that the reservation productivity, i.e. the productivity that makes the two partners of a match just indifferent between continuing production and separating, exists, is unique, and that it depends only upon the variables x and δ (this is done in Appendix A.2.4.). Hence, one can define reservation productivity levels for the decision to form and to destroy a match, respectively. There is one reservation productivity level for match formation, which implies a reservation value for each of the two variables (note that both x and δ are realisations of random variables at the time of matching): R^o_x indicates a cut-off value for δ, given x. Because productivity *falls* with rising mismatch, this value is an *upper bound* for the value that mismatch assume in a productive match. If the measure of mismatch rises above this threshold, the match does not come into existence. From the point of view of the firm, whose skill requirement is fixed, this implies a lower and an upper bound for the worker's skill. The second reservation value for job creation is R^o_δ, which, as in the standard search model, is the *lower bound* for x in a productive match. As for job destruction, skill mismatch δ is known. Therefore, the reservation threshold is characterised by one unknown variable only: R_δ indicates the threshold value for x, given δ. If the stochastic variable x falls below this value, the match separates. Furthermore, with endogenous job destruction and Nash bargaining, both match formation and separations will be consensual. From the Nash bargain, the reservation values satisfy the following conditions:

$$J^o(R^o_\delta, \delta) = 0 \tag{2.12}$$

$$J^o(x, R^o_x) = 0 \tag{2.13}$$

$$J(R_\delta, \delta) = -T \tag{2.14}$$

Given this reservation value, one obtains for the value functions:

$$\begin{aligned} rJ^o(x,\delta) &= \varphi(x,\delta) - w^o(x,\delta) \\ &\quad +\lambda \int_{R_\delta}^1 J(x',\delta)dF(x') + \lambda F(R_\delta)[V-T] - \lambda J(x,\delta) \qquad (2.15) \\ rJ(x,\delta) &= \varphi(x,\delta) - w(x,\delta) \\ &\quad +\lambda \int_{R_\delta}^1 J(x',\delta)dF(x') + \lambda F(R_\delta)[V-T] - \lambda J(x,\delta) \\ rV &= -c + q(\theta) \int_0^{\overline{R^o_x}} \int_{\underline{R^o_\delta}}^1 [J^o(x',\delta') - V] dF(x')dG(\delta') \qquad (2.16) \\ rW^o(x,\delta) &= (1-\tau)\cdot w^o(x,\delta) \\ &\quad +\lambda \int_{R_\delta}^1 W^o(x',\delta)dF(x') + \lambda F(R_\delta)U - \lambda W^o(x,\delta) \qquad (2.17) \end{aligned}$$

$$
\begin{aligned}
rW(x,\delta) &= (1-\tau)\cdot w(x,\delta) \\
&\quad +\lambda\int_{R_\delta}^{1} W(x',\delta)dF(x') + \lambda F(R_\delta)U - \lambda W(x,\delta) \qquad (2.18)\\
rU &= (1-\tau)\cdot b \\
&\quad +\theta q(\theta)\int_0^{\overline{R_x^o}}\int_{\underline{R_\delta^o}}^{1}[W(x',\delta') - U]dF(x')dG(\delta') \qquad (2.19)
\end{aligned}
$$

where $\overline{R_x^o}$ is implicitly defined by $J^o(1, R_x^o) = 0$. This means that it is the highest value δ can take in a productive match, considering all possible values of x. If δ lies above this threshold, no production takes place, no matter what the level of x is. This value is obviously attained when $x = 1$. Conversely, $\underline{R_\delta^o}$ is implicitly defined by $J^o(R_\delta^o, 0) = 0$, i.e. it is the lowest value that x can take in a productive match, considering all possible values of δ.

The equilibrium conditions

In order to obtain an analytic solution to the model, I set initial productivity equal to one, i.e. $x_0 = 1$. Equilibrium in the labour market is then described by a system of four equations, which gives us the solution to the four unknowns market tightness (θ), unemployment (u), and the reservation thresholds R_δ and R_x^o. I show in Appendix A.2.4 that the first three equations read as follows:

$$
\begin{aligned}
\frac{c}{q(\theta)} &= \frac{(1-\beta)}{r+\lambda}\int_0^{R_x^o}[\varphi(1,\delta) - \varphi(R_\delta,\delta)]dG(\delta) \\
&\quad -(1-\beta)T \qquad (2.20)\\
\varphi(1,R_x^o) &= b + \frac{\beta}{1-\beta}\theta c + \lambda T \qquad (2.21)\\
\varphi(1,R_x^o) - \varphi(R_\delta,\delta) &= (r+\lambda)T \qquad (2.22)
\end{aligned}
$$

Figure A.2 depicts equations (2.20), the labour demand (LD) curve, and (2.21), the tightness curve, in $\varphi(R_\delta,\delta) - \theta$-space. The labour demand curve represents a negative relationship between reservation productivity and tightness. The relationship is negative because with a higher reservation productivity, firms open up fewer vacancies because the expected duration of a vacancy is high, i.e. expected search costs are high. The tightness curve is a positive relationship between the two variables. The reason for this is that higher market tightness increases the value of unemployment, decreasing the willingness of unemployed workers to take up a job and thus raising reservation productivity R_δ. Together, the two curves yield the equilibrium values of labour market tightness and reservation productivity for given values of unemployment benefits b and taxes τ. The reservation productivity condition, equation (2.22), shows that the firing costs drive a wedge between the job creation and the job destruction threshold. For a given value of R_δ, I get a value for R_x^o. This is depicted in Figure A.4. Note that if firing costs were equal to zero, the two reservation thresholds would be identical.

The level of unemployment is determined through equilibrium in the labour market. The latter obtains when flows into and out of unemployment, i and o, are equalised. Inflows into unemployment are given by the mass of profitable jobs being hit by a shock which makes them unprofitable. Outflows from unemployment are equal to the product of the number of unemployed workers and the probability of a worker finding a job which is profitable.

$$\begin{aligned} i &= \lambda \int_{\underline{R_\delta}}^{1} e(x,\delta) F(R_\delta) dG(\delta) \\ o &= u \cdot \theta q(\theta) \int_0^{\overline{R_x^o}} \int_{\underline{R_\delta^o}}^{1} dF(x) dG(\delta) \end{aligned}$$

Equilibrium in the labour market yields the following condition:

$$\lambda \int_{\underline{R_\delta}}^{1} e(x,\delta) F(R_\delta) dG(\delta) = u \cdot \theta q(\theta) \int_0^{\overline{R_x^o}} \int_{\underline{R_\delta^o}}^{1} dF(x) dG(\delta) \tag{2.23}$$

Together with the labour demand curve, equation (2.23) determines the number of vacancies and the level of unemployment for given values of market tightness and employment distribution. This relationship, the Beveridge Curve, is depicted in Figure A.3 in the appendix.

Finally, the equilibrium tax rate is determined by the government budget constraint:

$$\begin{aligned}(1-\tau)b\cdot u &= \tau\int_0^{\overline{R_x}}\int_{\underline{R_\delta}}^1 w(x,\delta)\cdot e(x,\delta)dF(x)dG(\delta)\\ \tau &= \frac{b\cdot u}{b\cdot u+\int_0^{\overline{R_x}}\int_{\underline{R_\delta}}^1 w(x,\delta)\cdot e(x,\delta)dF(x)dG(\delta)}\end{aligned} \tag{2.24}$$

where $e(x,\delta)$ is employment at productivity $\varphi(x,\delta)$. Note that this expression features the inside values for the reservation productivities. The reason for this is that $\overline{R_x^o} < \overline{R_x}$ and $\underline{R_\delta^o} > \underline{R_\delta}$. By using the inside values, therefore capture all the $x-\delta$-combinations where production takes place.

Equations (2.20)-(2.24) fully characterise the equilibrium of the mismatch economy. Equilibrium exists and is unique.

2.4 Simulation

2.4.1 The Simulation Strategy

The simulation strategy consists of two steps. I first simulate the model for a low aggregate degree of mismatch and over a range of unemployment benefits and firing costs. As described in the introduction, both policy variables play two roles in the economy. On the one hand, firing costs imply that agents are pickier when deciding on whether to match or not, thus lowering match creation. On the other hand, they also lead to lower job destruction once a match has been formed, thus raising match duration. The replacement rate, and hence unemployment benefits, reduce the incentive for an unemployed worker to match, while providing a search subsidy at the same time. This first step aims at making clear the basic mechanisms at work in the model. As will become clear, the functioning of the model with endogenous job destruction is significantly different from one of the model with exogenous job destruction, as in Marimon and Zilibotti (1999). Ultimately, I am interested in the effect of an increase in skill mismatch on the unemployment rate in different economic regimes. Therefore, in the second step, I simulate the effect of an increase in mismatch in the economy. In order to keep the analysis tractable, I focus on three different economic regimes, which are characterised by different combinations of the levels of firing costs, T, and replacement rates, ρ. The first setting pertains to a "welfare state", called "Europe1" for simplicity, with positive unemployment benefits. The second setting, "Europe2" also describes a welfare state, with the same level of unemployment benefits and, in addition, a positive level of firing costs. The third regime describes a *laissez-faire economy*, e.g. the United States. For simplicity, I assume that the level of both unemployment benefits, and firing costs are zero in this economy. Using the simulations below, I want to examine which impact the different scenarios have, given different institutional backgrounds. The quantitative results of this exercise will allow us to make a judgement on the importance of mismatch in generating the differing labour market outcomes in the US and in "Europe".

It is unfortunately not possible to simulate the above model without modification. The reason for this is that, given the values for the variables and parameters stated below, for very low values of mismatch some matches never get destroyed, no matter what the value of idiosyncratic productivity is. In other words, for very low values of mismatch, employment becomes an absorbing state. Itherefore introduce *exogenous separations* over and above the endogenous separations present in the model described in the previous sections.[14] In particular, I postulate that a match that has not been hit by an idiosyncratic productivity shock has a positive probability s of being separated for exogenous reasons. This implies that even matches with a very low degree of skill mismatch can get destroyed. I regard the presence of some exogenous job destruction as a realistic feature of the model. I simulate the model by iterating recursively on the value functions, the distribution of employment, and the government budget constraint, making sure to obtain the desired levels of unemployment inflows and the replacement rate, and taking

[14]Note that this slightly changes the value functions. However, this does not affect the validity of the analytic results derived above.

into account the government budget constraint. Unemployment benefits are chosen such as to match the replacement rate. The algorithm used is as follows:

1. Start with an initial guess for the value and the level of unemployment, U and u, respectively, the exogenous separation rate s, the tax rate τ, and unemployment benefits b.

2. Compute the decision rules, the agents' value functions, and the wages.

3. Compute the distribution of employment over x and δ, the level of unemployment, and the inflows into and outflows from unemployment.

4. Given the level of endogenous inflows into unemployment, set s such that overall inflows into unemployment amount to 0.04.

5. Given the wages in the economy, set unemployment benefits such that the replacement rate is attained.

6. Compute the tax rate necessary to finance unemployment benefits, given the distribution of employment in the economy.

7. Repeat steps (2)-(6) until convergence.

The parameters featuring in Marimon and Zilibotti (1999) are set at similar values as in their simulation exercise in order to be able to compare my results with theirs. This includes setting the discount factor to 0.935. Given the time period of one quarter, this implies an annual interest rate of 1.7%. The grids for skill mismatch δ and stochastic productivity x lie in the intervals $[0, 0.5]$ and $[\eta, \eta + 1]$, respectively. The parameters for skill mismatch are $a = 0.5$ and $\gamma = 2$, respectively. The initial flow cost incurred by a vacancy is $c_0 = 2.25$. Generally, the "0"-subscript denotes values for parameters in the baseline simulation with low skill mismatch. The stochastics are as follows. The draws of x and δ are taken from uniform distributions on their respective intervals. Following Mortensen and Pissarides (1999a), the shock arrival rate λ is set equal to 0.1. The matching technology is Cobb-Douglas, with parameters A and α, i.e. $m(v, u_k) = Au_k^{\alpha}v^{(1-\alpha)}$. The parameter value for the elasticity of the matching function is chosen as common in the literature, i.e. $\epsilon = 0.5$. The sharing parameter in the Nash bargain is $\beta = 0.5$. The parameter values are summarised in Table 2.1:

Table 2.1: Parameter values used in the baseline simulation.

β	c_0	η_0	λ	ϵ	r
0.5	2.25	2.25	0.1	0.5	0.017

2.4.2 The Baseline Model

A discrete version of the mismatch model for a low degree of aggregate mismatch, α, is simulated following the algorithm stated above. As expected, the surplus is rising in x, idiosyncratic match productivity, and falling in δ, the degree of mismatch between the worker's skill and the firm's skill requirement. This is shown in Figure A.5 in the appendix. The resulting distribution of employment in $x - \delta$-space is depicted in Figure A.6. As new matches are created at maximum idiosyncratic productivity x, employment in this range is highest. It is furthermore visible that there are positive employment levels at all rates of idiosyncratic productivity x, as idiosyncratic mismatch, δ, becomes very small. In other words, matches characterised by a very low degree of idiosyncratic mismatch do not get destroyed endogenously, but only by the exogenous job destruction process present in the simulation.

In order to investigate the effect of the policy parameters, I calibrate the model for different values of the replacement rate, ρ, and of firing costs, T. The results are documented in Table 2.2.

It becomes apparent that unemployment is generally rising with the replacement rate and with firing costs. These results come about because endogenising the job destruction decision considerably alters the dynamics of the model. This issue is therefore investigated in more detail. For ease of exposition, I focus on the three different economic regimes described above.

Table 2.2: Unemployment rates at different levels of replacement rate ρ and firing costs T, in per cent, $\alpha = 0.5$.

		T=					
		0	0.5	1	1.5	2	2.5
	0	4.75	4.76	4.79	4.81	4.84	4.87
	0.1	4.74	5.01	5.04	5.07	5.10	5.12
$\rho =$	0.2	5.06	5.27	5.30	5.34	5.37	5.40
	0.3	5.31	5.57	5.62	5.66	5.69	5.73
	0.4	5.52	5.96	6.00	6.04	6.09	6.13
	0.5	5.88	6.37	6.48	6.53	6.58	6.62

The *laissez-faire* state (U), is characterised by a replacement rate of 0 and no firing costs. The other two regimes feature a replacement rate of $\rho = 0.2$, but differ in the level of firing costs: the first welfare state regime (E1) does not have any firing costs, in the second welfare state regime (E2), firing costs are set equal to $T = 1$. The parameter values used for the three scenarios are in Table 2.3.

Table 2.3: Policy parameters for the three scenarios.

	U	E1	E2
ρ	0	0.2	0.2
T	0	0	1

The second column in Table 2.4 summarises the key results. The effect of the policy parameters on the outflow rate from unemployment is most straightforward. As a comparison between the rates for regimes E1 and E2 makes clear, increasing firing costs at the same level of unemployment benefits reduces the outflow rate from unemployment. The same is true for the replacement rate, as can be seen from the comparison between E1 and U. This is due to the fact that the reservation wage where a worker accepts a job offer is higher in E1. In other words, workers are choosier with respect to job offers. As was pointed out above, this is the *disincentive effect* of unemployment benefits. However, the *search subsidy* effect is also clearly present in the model. In order to illustrate this, I calculate the average idiosyncratic mismatch per match. For every match, I calculate the idiosyncratic degree of mismatch between the firm's skill requirements and the worker's skills, and then take the average over these degrees of mismatch. The results of this exercise are also displayed in Table 2.4. Clearly, E1 features the lowest degree of mismatch. In regime E2, which is characterised by both a positive replacement rate and firing costs, the degree of average idiosyncratic mismatch is still lower than in U, where both policy parameters are set to zero. This is due to the fact that in E2, the search subsidy effect of unemployment benefits is present. E2, however, features a higher degree of average idiosyncratic mismatch than E1, because matches characterised by high mismatch are not destroyed as quickly as they are in E1 when a bad idiosyncratic productivity shock arrives. To put it differently, "bad" matches survive longer in the presence of firing costs, which raises the average idiosyncratic degree of mismatch.

The search subsidy effect is also visible when looking at the change in the unemployment rate as ρ increases from 0 to 0.1 with $T = 0$ fixed, which can be seen in Table 2.4. In this case, the unemployment rate actually falls as the replacement rate goes up. Overall however, the disincentive effect prevails over the search subsidy effect, but unemployment rises less with unemployment benefits than in the model without skill mismatch.

Raising firing costs for given levels of the replacement rate in this simulation unambiguously leads to an increase of the unemployment rate. As discussed above, there are two mechanisms at work here. On the one hand, there is less job creation as firing costs rise. This is witnessed by the lower level of market tightness when comparing E2 to E1 in Table 2.4. On the other hand match duration increases. However, because of the simulation strategy, the latter effect is limited. Therefore, the effect which increases the life expectancy of a match is clearly outweighed by the effect hampering job creation. As a result, higher firing costs raise the unemployment rate.

Finally, the presence of both ex-ante heterogeneity and endogenous job destruction leads to an effect on production and productivity which might at first appear somewhat counterintuitive. Both total production and production per employed worker are *lowest* in E1, despite the fact that average idiosyncratic mismatch per match is also lowest in this regime. To understand this result, it is important to recall that production of a match consists of two components, idiosyncratic productivity, x, and idiosyncratic mismatch, δ, which is fixed over the lifetime of a match. With relatively high unemployment benefits, the mass of matches is concentrated where idiosyncratic mismatch is low, no matter what idiosyncratic productivity x is. This means that there is also a larger mass of matches with low mismatch and very low idiosyncratic productivity - which together yields low output, and low output per worker. Correspondingly, with high unemployment benefits, there is only a small mass of matches which are characterised by high mismatch. This is due to the fact that the relatively high outside option leads workers to leave matches with high idiosyncratic mismatch as soon as idiosyncratic productivity x worsens. With low unemployment benefits, there are more matches with high idiosyncratic mismatch, but relatively high idiosyncratic productivity x, and less matches with low idiosyncratic mismatch, but relatively low idiosyncratic productivity x. To illustrate this point, Figure A.7 depicts the difference in steady-state employment levels between the regime with a positive replacement rate and no firing costs (E1) and the regime with a zero replacement rate (U). This illustrates that there are more matches featuring low idiosyncratic mismatch, and less matches featuring high idiosyncratic mismatch and high idiosyncratic productivity, when the replacement rate is higher. Furthermore, the sharpest falls in employment occur where the higher reservation wage makes matches unacceptable to workers.

These features are also witnessed by the fact that the endogenous inflows into unemployment coming from matches with high idiosyncratic mismatch δ is higher in the regime with high unemployment benefits. Interestingly, at positive firing cost levels, this effect is reversed does not occur. With $T > 0$, production and productivity per capita rise with the level of unemployment benefits.[15] The reason for this is that, in this case, there are more matches

[15]These results are not reported here, but can be obtained upon request.

with high mismatch and relatively low productivity x, and hence less matches with low mismatch and relatively low productivity.

2.4.3 Increasing Mismatch

Having discussed the basic functioning of the model, I now want to analyse the impact of higher aggregate skill mismatch in the economy for the three different economic policy regimes. Except for the replacement rate and the firing costs, all parameter values are exactly the same in the two regimes. The extent of mismatch prevailing in the economy is modelled by a change of the parameter α. Following Marimon and Zilibotti (1999), I increase α from 0.5 to 0.85, thus increasing the importance of mismatch in the production function, and set $c_1 = 2.4$ and $\eta_1 = 2.4$. I then compare the ensuing steady states. The results are summarised in Table 2.4.

In this model with endogenous job destruction and ex-ante heterogeneity, an increase in aggregate mismatch leads, somewhat surprisingly, to a *reduction* of the unemployment rate in all three regimes. The reason for this is a mechanism similar to the one which is at work in the baseline model. When aggregate mismatch rises, average idiosyncratic mismatch per match *falls* in all three regimes. This is due to the fact that the mass of matches is shifted from matches characterised by high idiosyncratic mismatch to matches featuring low mismatch - as shown by the increase of the inflow rate into unemployment. The inflow rate increases strongly for matches characterised by high mismatch, which leads to an overall increase in the endogenous unemployment inflow rate.

The shift towards matches which feature low mismatch has further consequences. First of all, these matches are more stable than the matches with high idiosyncratic mismatch. The duration of these matches therefore increases. Second, both total production and production per employed worker rise. This is the case because there are less matches with high idiosyncratic mismatch.

As for wages, I calculate the ratio between the upper decile of the wage

Table 2.4: Comparison between steady-states

		$\alpha = 0.5$	$\alpha = 0.85$
Unemployment rate	E1	5.06	5.01
	E2	5.30	5.23
	U	4.75	4.68
Inflow rate	E1	2.20	2.25
	E2	1.65	1.83
	U	2.07	2.22
Inflow rate $\delta = \delta_{max}$	E1	4.71	5.88
	E2	3.53	4.71
	U	4.14	5.33
Outflow rate	E1	0.91	0.92
	E2	0.89	0.91
	U	1.00	1.02
Ratio between 90th-10th wage percentile	E1	1.21	1.22
	E2	1.26	1.28
	U	1.22	1.24
Market tightness	E1	0.82	0.85
	E2	0.80	0.82
	U	1.00	1.03
Total production	E1	2.48	2.78
	E2	2.53	2.82
	U	2.55	2.84
Production per employed worker	E1	2.62	2.92
	E2	2.67	2.97
	U	2.68	2.98
Average idiosyncratic mismatch per match	E1	0.17	0.16
	E2	0.19	0.18
	U	0.20	0.19

Notes: All rates except for inflow and outflow rates in per cent, inflow rates include endogenous inflows only.

distribution and the lower decile of the wage distribution. In the laissez-faire state, this measure of wage inequality increases by 0.7%, which is low compared to the figures reported by Marimon and Zilibotti (1999). The increase is caused by the fact that, with a greater importance of mismatch in the production function, earnings become more variable, depending on whether a match displays a higher or a lower degree of mismatch. In the welfare state, an increase in a also leads to a rise in wage inequality. However, at 1.8%, the rise is higher, contrary to what one might have expected. This is again due to two opposing effects of unemployment benefits. On the one hand, unemployment benefits cut out low-paying jobs, which reduces wage inequality by raising the level of wages and compressing the wage structure. On the other hand, a closer inspection of the wage distribution (not presented here) reveals that the increase in wage inequality is caused by a greater mass of workers employed in matches featuring low mismatch and low idiosyncratic productivity. Such matches yield a relatively low wage. The greater mass of workers in these jobs is caused by the search subsidy effect of unemployment benefits. Workers stay in those low-paying jobs because they expect idiosyncratic productivity to rise again, i.e. the option value of their current job is high. Finally, total production increases in both regimes, the reason being that both employment and mean production rise. Again, there is no qualitative difference between the two regimes. The reason for this is the same as for the evolution of wages: unemployment benefits make some “bad" jobs disappear. But this effect is undone by the shift of the distribution of employment towards matches characterised by low mismatch and (temporarily) low idiosyncratic productivity.

The reason why this effect does not feature in the model by Marimon and Zilibotti (1999) is that they regard job destruction not only as exogenous, but also as equal across match qualities. This implies that workers are not allowed to react to a shock by changing the reservation productivity level R_δ. Clearly, this leaves out the mechanism described above.

In summary, the above results show that endogenising job destruction in a model with skill-mismatch à la Marimon and Zilibotti (1999) completely undoes the results obtained in a model with exogenous job destruction. With exogenous job destruction, the *disincentive* effects of unemployment benefits outweigh the *search subsidy* effects, raising unemployment as overall skill mismatch in the economy increases. With endogenous job destruction and Nash bargaining, on the other hand, the second effect prevails, which leads to a shift of the distribution of productive matches towards low-mismatch matches. The latter are characterised by low levels of job destruction, which reduces inflows into unemployment and also the unemployment rate. This mechanism also yields some unexpected results: low-mismatch matches do not necessarily pay high wages for any realisation of idiosyncratic productivity x, but do not get destroyed endogenously because of their high option value. However, this means that these low-paying matches contribute to an increase in wage inequality.

2.4.4 Discussion and Extensions

In the simulation above, increased skill mismatch has a negligible effect on unemployment. The reason for this is that the endogeneity of the job destruction affects the average quality of matches. Workers accept temporary wage cuts if they are in a match characterised by low mismatch and low idiosyncratic productivity x. Matches featuring a high degree of mismatch, on the other hand, are quickly abandoned. The distribution of matches is therefore shifted towards low skill mismatch, which lowers unemployment. Thus, for workers there is a trade-off between accepting a (temporarily) lower wage and greater job stability.

Two crucial assumptions of the above model are, first, that unemployment benefits are independent of previous wages, and second, that wages are free to adjust to economic shocks. The effect of the key mechanism described above is reduced when wages react less to unemployment than in the present setting with Nash bargaining and endogenous job destruction. One way of incorporating this into the model is to follow Hall and Milgrom (2005) who propose to change the fallback position of employed workers in the bargain. They argue that the relevant fallback of workers engaged in a wage bargain is the value of the last wage they obtained, and not the value of unemployment. Introducing such a mechanism into the model reduces the possibility of the partners to a good match of cutting wages when idiosyncratic productivity falls, and therefore of preserving the match. In other words, more “good" matches are destroyed, which leads to higher inflows into unemployment. It also lowers the expected value of a new match. Therefore vacancies, and thus outflows from unemployment, do not rise sufficiently to keep the unemployment level constant. As a consequence, the level of unemployment increases. By how much it is raised depends on the degree of wage rigidity in the economy. The higher wage rigidity, the closer the results get to the ones obtained by Marimon and Zilibotti (1999) as job destruction becomes effectively exogenous. The question then is which wage setting mechanism can be regarded as the most appropriate one. In particular, one has to ask the question how workers have reacted in terms of setting wages to the adverse shocks that occurred in the 1970s. This topic, however, is beyond the scope of this paper.

As for unemployment benefits, introducing path-dependent benefits changes the dynamics of unemployment flows because incentives are affected. If highly-paid workers obtain high unemployment benefits, they are more likely to end a match as productivity worsens than if they are paid the same, lower, unemployment benefits. This means that more matches of high quality get destroyed, which in turn raises unemployment. Introducing those two extensions into the model is left for future research.

2.5 Conclusion

The aim of this paper was to analyse a model featuring both endogenous job destruction and skill mismatch in the form of *ex ante* heterogeneity of firms and workers. In other words, the model combines the Mortensen and Pissarides (1994) model of endogenous job destruction with the skill mismatch model by Marimon and Zilibotti (1999). The workings of the new "hybrid" model are very different from either of the two underlying models. Endogenous job destruction leads to a shift of the distribution of employment relationships towards matches characterised by low mismatch. Matches featuring high idiosyncratic mismatch get destroyed more quickly than matches with low idiosyncratic mismatch. This also plays a role when analysing the effects of labour market policy instruments: Unemployment benefits exacerbate the shift towards low-mismatch matches. The reason for this is that workers use unemployment benefits as *search subsidy*. This means that, on the one hand, unemployment duration is increased because workers have a higher reservation wage at higher levels of unemployment benefits. On the other hand, there is also an impact on the duration of employment spells. Workers more quickly leave matches characterised by high idiosyncratic mismatch when they receive unemployment benefits. As opposed to that, matches characterised by low idiosyncratic mismatch become more stable. While the effect on the duration of unemployment is present in models with exogenous job destruction, the effect on the duration of employment can only be analysed in a modelling framework such as the one presented which features endogenous job destruction.

Having analysed the basic workings of the model, the paper then assessed the extent to which skill mismatch can account for the increase in unemployment since the 1970s in Europe relative to the US. To do so, I subjected three economic regimes, one a laissez-faire economy (proxying the US), and two types of "welfare state" (featuring a strictly positive replacement rate - thus proxying "Europe", and, in one case additional firing costs), to the same shock. This shock increased the importance of skill mismatch in the production function. It turned out that, for realistic parameter values, this even lead to a *fall* in the unemployment rate in all three regimes. This is due to the fact that the distribution of matches shifts towards matches characterised by low mismatch, with a high expected duration. In other words, the shock to skill mismatch exacerbates the mechanism described above. This result stands in contrast with the results in Marimon and Zilibotti (1999) who argue that a shock to skill mismatch, in combination with generous labour market institutions, can lead to higher unemployment. However, their model features exogenous job destruction only. Workers are therefore by construction not allowed to hang on longer to a "good" job (featuring low skill mismatch) in case of an adverse shock. This feature potentially plays a crucial role in any model with exogenous job destruction featuring a comparative statics exercise.

From a technical perspective, I showed that, given certain assumptions, two-sided ex-ante heterogeneity of firms and workers is equivalent to ex-post heterogeneity with fixed match (not agent) characteristics. This proved helpful in both the analytical solution and the calibration of the model, as the distribution of vacancies and unemployed workers can be neglected.

More generally, these results lead me to argue that endogenous job destruction should be considered in any search model in which matches feature characteristics which have an impact on productivity and which are fixed during the lifetime of a match. The reason for this is that such match characteristics lead to different reservation productivity thresholds, and hence job destruction decisions, across heterogeneous matches. This has important implications for the distribution of match quality in the economy and is only taken into account in models with endogenous job destruction.

Chapter 3

Labour Market Dynamics in Germany: Hirings, Separations, and Job-to-Job Transitions Over the Business Cycle

This paper analyses the cyclical properties of gross worker flows, accessions, and separations in western Germany in 1975-2001 based on a dataset that contains daily information on 2% of the German workforce covered by social security legislation. Separations are found to be relatively flat over the cycle, while accessions are markedly procyclical. The increased flow into unemployment in a recession is therefore due to reduced hirings, and lower job-to-job transitions, rather than increased match separations. I argue that this finding can be explained by differences in the cyclical characteristics of the worker flows underlying accessions and separations. This important feature of labour market dynamics is ignored by the standard two-state search and matching model. Furthermore, this finding implies that the focus of economists and policy makers on firing restrictions might have been exaggerated. Instead, more attention should be directed to studying firms' hiring behaviour. These findings thus have important implications both for the way labour market dynamics should be modelled and for the way we evaluate labour market policies.

3.1 Introduction

There used to be a consensus among macroeconomists about the reason for increased unemployment inflows during a recession: a negative productivity shock leads to a burst in match break-ups, which in turn results in previously employed workers becoming unemployed. This seemed to be a natural conclusion emanating from the stylised facts about job creation and destruction. Most prominently, Davis et al. (1996) found job destruction to be much more volatile than job creation in the manufacturing sector of the US. Furthermore, this mechanism features prominently in the standard search and matching model of the labour market as epitomised in Mortensen and Pissarides (1994). This view has however been challenged by recent empirical research on the US labour market.[1]

In this paper, I analyse the cyclical properties of accessions, separations, and job-to-job transitions on the West German labour market. This is done using a very large micro data set which derives from registry data, the IAB employment sample, which covers the years 1975-2001. As described in detail below, these data make it possible to observe a very large number of employees on a daily basis over a time span of 26 years. This enables me to record worker transitions on the labour market, including job-to-job flows, on a daily basis for two full business cycle swings. I am therefore able to exactly quantify worker flows, and to provide a comprehensive analysis of their cross-sectional and time-series properties. Furthermore, the data set makes it possible control for unobserved heterogeneity in the econometric analysis. As opposed to the US studies relying on monthly survey data, this data source is very accurate as it provides daily employment and unemployment records, it covers a much longer time span, and it follows the same workers over a long period of time.[2]

[1] Blanchard and Diamond (1990) were among the first to provide direct evidence on gross worker flows in the US. Fallick and Fleischman (2004), Nagypál (2004), Hall (2005b), and Shimer (2005b) extend this analysis by including job-to-job transitions in the US for the time period 1994-2003. This literature is discussed in more detail in the next section.

[2] As described below, direct evidence on job-to-job transitions in the US is only available

In terms of results, the contributions of the paper are as follows. First, while I do confirm many of the findings by the authors cited above, I am able to give a more detailed picture of the cyclical response of labour market flows. Looking at the West German economy, I corroborate the findings for the US that the decline of job-to-job transitions contributes at least as much to worker flows into unemployment during a recession as do increased lay-offs. This points to the importance of the *hiring* activity of firms for the cyclical features of labour market flows. I also show that one should not only look at gross hirings, separations, and job-to-job transitions. One of the key points of this paper is that it is important to look at the flows underlying hirings and separations. Such an analysis shows that two facts lead to the observed cyclicality of hirings and separations: on the one hand, flows underlying separations are more strongly, and negatively, correlated, which in the aggregate leads to relatively flat separations; on the other hand, some of the flows making up separations are less volatile themselves. These findings have important implications for the way we think about labour market dynamics. In particular, empirical work stressing the flatness of separations has lead many theorists (e.g. Hagedorn and Manovskii, 2005) to use business cycle models featuring an exogenous match separation process. As will be discussed in more detail below, in the light of the empirical evidence presented in this paper, this is not warranted.

The plan of the paper is as follows. In the next section, I give a brief overview of the literature on the cyclical features of worker flows in the labour market, and job-to-job transitions in particular. In section 3.3, I describe the data set used and the theoretical concepts underlying the empirical analysis. Furthermore, I discuss measurement issues. Section 3.4 presents the empirical evidence in the following way: In Section 3.4.1, I give an overview of gross worker flows in western Germany. In particular, I study the relative importance of the different flows. Section 3.4.2 analyses which impact worker heterogeneity has on the cross-sectional properties of gross labour

in the Current Population Survey from 1994.

market flows. Finally, Section 3.4.3 investigates the cyclical properties of gross worker flows, as well as the question whether it is increased match separations or a reduced hiring activity which lead to increased worker flows into unemployment in a recession. Section3.6 summarises the main findings and concludes.

3.2 Hirings, Separations, and Job-to-Job Transitions in the Literature

Nagypál (2004) and Fallick and Fleischman (2004) provide direct evidence on gross worker flows, including job-to-job transitions, in the US for the time period 1994-2003. Both papers exploit the "dependent interviewing" techniques introduced in the Current Population Survey (CPS) in 1994. Nagypál (2004) finds that, while separations are relatively flat over the business cycle, accessions are much more volatile, and puts this down to a decline in job-to-job transitions during recessions. Fallick and Fleischman (2004) provide similar evidence by pointing out that job-to-job transitions are large, that they are procyclical, and that they are centered around the recession.[3] For France, related evidence was presented by Abowd et al. (1999). Using a representative sample of French establishments they find that employment adjustment occurs primarily through changes in entry rates and not through exit rates (excluding quits). However, it should be pointed out that their analysis only covers the time period 1987 to 1990, which means that they focus on idiosyncratic, rather than cyclical, variation in employment.

These empirical findings have been formalised by Shimer (2005b). He shows that in a search model where unemployed workers accept any job

[3]It should, however, be pointed out that the pro-cyclicality of quits was already recognized by Akerlof et al. (1988). Furthermore, Mortensen and Pissarides, despite being the starting point of the described conventional wisdom, are well aware of the fact that “flows into employment are strongly pro-cyclical and separations mildly pro-cyclical or neutral” (cf. Mortensen and Pissarides, 1999a). Pissarides (1986) already notes the importance of unemployment outflows for the dynamics of the stock of unemployment.

and employed workers move to better jobs, the cyclicality of the job-to-job transition rate depends on the nature of the shock. While fluctuations in the separation rate lead to a countercyclical transition rate, fluctuations in the job finding rate lead to a procyclical job-to-job transition rate. As it is the latter that we observe, fluctuations in the job finding rate play a more prominent role over the cycle. Nagypál (2005) shows that this has important implications for the propagation of shocks. Because workers who have been previously employed are less likely to continue to search after moving to a new job, firms prefer to hire them instead of hiring the unemployed in order to save on future search costs. During booms, a large fraction of job seekers is employed, which raises expected profits. Therefore, firms create more vacancies thus enhancing the effects of a positive productivity shock. Krause and Lubik (2006b) develop a similar mechanism in a model with two types of jobs and highly elastic on-the-job search. In a boom, there is more on-the-job search, which leads to more creation of good jobs, and vice versa. This mechanism is self-reinforcing, which leads to increased persistence of productivity shocks. These studies thus stress the importance of direct job-to-job transitions for the role of the labour market as a propagation mechanism of productivity shocks. Hall (2005a) shows that the observed importance of hirings relative to separations emerges in a model with rigid wages where employment governance is efficient, i.e. where there are no inefficient separations. Finally, Mortensen and Nágypal (2005) develop a search and matching model with job-destruction shocks and job-to-job worker flows.[4] Given that the opportunity cost of continuing a job-worker match is high enough (where the opportunity cost includes both a worker's opportunity cost of employment and turnover costs), their model can explain U.S. labour market data with respect to both the volatility of vacancies and of unemployment, as well as the quantitative properties of the Beveridge curve.

Direct job-to-job transitions also have an important impact on the way we view recessions. The traditional view is the Schumpeterian one which

[4]The following applies to a substantially revised version of the working paper cited.

postulates that bad matches are weeded out during recessions. This conclusion follows also from the standard search and matching model of the labour market. There, a negative aggregate shock leads to the destruction of matches featuring low idiosyncratic productivity. This cleansing effect of recessions has however been challenged by Barlevy (2002). He argues that on-the-job search usually leads to better matches, as otherwise workers would not search while employed. If recessions hamper job-to-job transitions, then matches created during recessions are likely to be of lower quality. In this case, recessions could exert a sullying, rather than a cleansing, effect by worsening the quality of newly created matches.

Despite the perceived importance of accessions, separations, and direct job-to-job transitions for labour market dynamics, empirical evidence for Germany remains relatively scarce. Erlinghagen (2005) uses a representative German household survey, the German Socio-economic Panel (SOEP), in order to analyse the evolution of lay-offs and job security for the time period 1985-2001. He finds that the business cycle is the most important determinant for the observed evolution, and that there is no discernible long-run trend. Schmidt (2000a) also uses the SOEP, stressing the heterogeneous experience of different demographic groups, especially with respect to their sensitivity to cyclical factors. Finally, Fitzenberger and Garloff (2005b) use the same data source and calculate labour market transitions. They do not, however, specifically look at accessions and separations. Furthermore, they only consider year-on-year changes, which, as Ishow below, means that a lot of the actual dynamics are not recorded in their study.

The present analysis differs from the above studies in the following ways. First, as opposed to the existing German studies, I emphasise the role of accessions and separations in order to account for the evolution of labour market flows and unemployment. Second, as opposed to the US studies and as opposed to the German studies using the SOEP (Erlinghagen, 2005, and Schmidt, 2000a), I use a very large data set which derives from registry data, the IAB employment sample. As described below, these data make it possible to observe a very large number of employees on a daily basis over a time span of 26 years. This enables me to record worker transitions on the labour market, including job-to-job flows, on a daily basis for two full business cycle swings. I am therefore able to exactly quantify worker flows, and to provide a comprehensive analysis of their cross-sectional and time-series properties. The time span analysed is thus much longer than in the US studies which use the CPS.[5] Furthermore, I can control for unobserved heterogeneity in the econometric analysis, which is impossible in the CPS studies.

3.3 The Data, Concepts, Measurement

3.3.1 The Data Set

The data set used is the IAB Regional File 1975-2001 (IABS-R01), which is provided by the Institute for Employment Research (IAB) of the German Federal Employment Agency. The data base covers 2% of all the persons who, between the 1st January 1975 (for western German employees) or the 1st January 1992 (for eastern German employees) and the 31st December 2001, worked in an employment covered by social security. The data source consists of notifications made by employers to the social security agencies, which include health insurances, statutory pension schemes, and the unemployment insurance agencies.[6] These notifications are made on the behalf of workers, employees and trainees who pay contributions to the social insurance system. This means that, for example, civil servants and the self-employed are not included. Overall, the subsample includes over 1.29 million people, of which 1.1 million are from western Germany. For 1995, the employment statistics, from which the IAB Regional File is drawn, cover nearly 79.4% of the employed persons in western Germany, and 86.2% of all employed persons

[5]Direct evidence on job-to-job transitions is only recorded directly in the CPS from 1994.

[6]For a complete description of the data set, see Bender et al. (2000).

in eastern Germany. As for the unemployed, only those entitled to unemployment benefits are covered. This means that the unemployment stock is about one third lower compared to official labour statistics.[7] It should also be mentioned that the unemployment records are incomplete until 1979. I therefore only use information on unemployment from 1980.

The notification procedure is important for the measurement issues discussed below. For employment spells, notifications are made for the year when the spell begins, for every completed year of the spell, and for the year when the spell ends. To take an example, if an employment spell lasts from May 15, 1975 until the May 15, 1977, then there will be three notifications: one for the time period 15/5/1975-31/12/1975, one for the time period 1/1/1976-31/12/1976, and one for the time period 1/1/1977-15/5/1975. For unemployment spells, there is just one single record. The information provided for each spell is the following: sex, year of birth, and degree of education/training. Also, information on the occupation and the gross earnings of workers, an establishment number, and the economic sector is available on a daily basis. Two states of the labour market can be directly derived from the data set: employment covered by social security, and unemployment, if the worker is receiving some form of unemployment compensation. The third state considered, “non-participation”, is not directly recorded but can be inferred. It is defined as: not paying social security contributions while full-time employed, and not receiving unemployment benefits. This means that non-participation can coincide with the state “out-of-the-labour-force”. However, it can also mean self-employment, civil service employment[8], retirement, or marginal employment. Thus, for those ever registered with the social security system, “non-participation” provides an upper bound for “out-of-the-labour force”.[9]

The advantages of the data set are thus as follows: first, it does not suffer

[7] See Bender et al. (1999a).

[8] This applies to “Beamte”, public sector employees under a special, life-time form of civil service employment. Other workers in the public sector are included in the data set.

[9] Cf. Fitzenberger and Wilke (2004b) for an in-depth analysis of this issue.

from the problems inherent in most panel data sets, e.g. there is no sample attrition, and it follows workers over a long period of time because there is no need for rotation as in the CPS. Given the length of our times series, the evidence here is likely to be more conclusive than the US studies cited above, which observe only one episode of labour market tightening (1994-2000) and loosening (2000-2003). The data set used here covers two decades and two full business cycle swings. Second, it offers observations at a very high frequency, which means that every actual transition is observed. Again, this is a distinct advantage over survey data like the CPS or the SOEP, which does not record multiple transitions that take place between two interview dates and, in the case of the SOEP, uses retrospective data. There are two disadvantages to the data set. On the one hand, it is representative for the working population covered by social security legislation, and not the entire working population. It should be pointed out here that the share of workers covered by social security relative to total employment is large and relatively stable, at around 80 %. On the other hand, it only covers the unemployed who receive unemployment benefits. Therefore, this special structure of the data set has to be taken into account when interpreting the different flows however, especially the ones going to and from non-participation.

3.3.2 Theoretical Concepts

Given the data on the employment state of workers, it is possible to calculate worker flows. There are two basic options. First, one can use point-in-time comparisons. This implies checking the labour force state of each individual at two given dates (e.g. at the beginning of two consecutive months), and infer the ensuing flow from this comparison. Second, one can calculate flows cumulatively, i.e. take into account every change of state that takes place, even if there are several flows within a certain time period (e.g. a month). As the data record every single move with daily accuracy, I opt for the latter approach. Abstracting from labour force growth, this concept yields the following stock-flow identities:

$$e_{t+\tau} = e_t + ue_{t+\tau} + ne_{t+\tau} - (eu_{t+\tau} + en_{t+\tau}) \quad (3.1)$$

$$u_{t+\tau} = u_t + eu_{t+\tau} + nu_{t+\tau} - (ue_{t+\tau} + un_{t+\tau}) \quad (3.2)$$

Here, e_t and u_t denote the stocks of employment and unemployment at the end of a given time period. Importantly, $xy_{t+\tau}$ indicates the *sum of all transitions* from state x to state y during time period $[t, t+\tau]$. Equation 3.1 shows that the employment stock at date $t+\tau$ is given by employment at date t plus any inflows during the time period $[t, t+\tau]$ that originated from unemployment (measured by $ue_{t+\tau}$) and from non-participation (measured by $ne_{t+\tau}$), minus outflows from employment to unemployment ($eu_{t+\tau}$) and to non-participation ($en_{t+\tau}$). The unemployment stock follows a similar calculation in equation 3.2. Note that job-to-job transitions do not feature in these stock-flow identities, as they do not change the stocks. Furthermore, it is worth emphasising that the IAB data set makes it possible to use this cumulative calculation, thus taking into account very short spells as well, which are usually not recorded in other data sets.

There are also two basic choices for normalising the worker flows. First, one can normalise the flows by the labour force. This makes it possible to abstract from labour force growth, which facilitates international comparisons. However, the data set does not record the stock of non-registered workers. I therefore restrict the definition of the labour force, l_t, to the sum of the stocks of the employed and of the unemployed, i.e. $l_t \equiv e_t + u_t$. Using the notation above, the normalised flows are then given by $xy_{t+\tau}/l_t$. This also approximately yields the probability of a worker in the labour force making one such transition during a certain time interval. The other option is to calculate transition probabilities conditional on the state of origin, i.e. the probability of a worker to make a specific transition, given the worker's state. For example, the average probability of an unemployed worker to make a transition to employment is given by $ue_{t+\tau}/u_t$, and the inverse of this ratio is the duration of unemployment. Both concepts are used in the subsequent analysis.

3.3.3 Measurement

As it is possible to track the employment and unemployment history of every person in the data set, it is possible to construct worker flows for the aggregate economy. I compute the flows between the three mentioned states and within the employment state in the cumulative way described above. It should be noted here that the notion of a job is establishment (not firm) based. This means that a change of establishment within the same firm will also be recorded as a job change.

It has to be taken into account that there might be measurement error in the data because of the way the data are collected. In particular, workers' notifications of becoming unemployed or leaving the state of unemployment might not always correspond exactly to the actual change of labour market state. For example, this can arise when a worker gets laid off and does not report to the unemployment office immediately. I correct for this latter potential measurement error in the following way: If the time interval between two records (employment or unemployment) is smaller than 30 days, then this is counted as a direct transition between the two states recorded.[10] If the gap between two notifications is larger than 30 days, then this is counted as an intervening spell of non-participation. As for job-to-job flows, records that are from the same person and the same establishment are counted as one single spell as long as the time between two consecutive employment notifications does not exceed 7 days. The latter issue arises in the case of annual notifications (see Section 3.3.1).

As I am interested in consistent time series that go back as far as possible, the empirical analysis only considers workers from western Germany. As there is no information on the place of residence in the data set, I discard observations on employees that at some point have worked in eastern Germany.

[10] I did the calculation for smaller intervals as well. This does not change the results significantly.

I also discard some worker groups, such as artists, who feature an implausibly high number of spells. As these observations are due to administrative rules, they are not interesting from an economic point of view. I therefore drop these observations from the data set by eliminating all observations for any person who features more than 200 employment spells over the time period considered.

Unfortunately, the records on unemployment benefit recipients are incomplete during the time period 1975-79. Therefore, the stock of those people, as well as the flows to and from that state, cannot be used for the analysis before 1980. As employment is correctly measured, I nevertheless obtain reliable estimates for direct job-to-job transitions, and for separations and accessions. However, it is not possible to decompose the latter two time series into their constituent parts before 1980. Therefore, one cannot tell neither the destination of a worker who leaves the state of employment, nor the origin of a worker who enters employment before 1980. It is however possible to do so from 1980 onwards. The empirical results are in the next section.

3.4 Gross Worker Flows in Western Germany

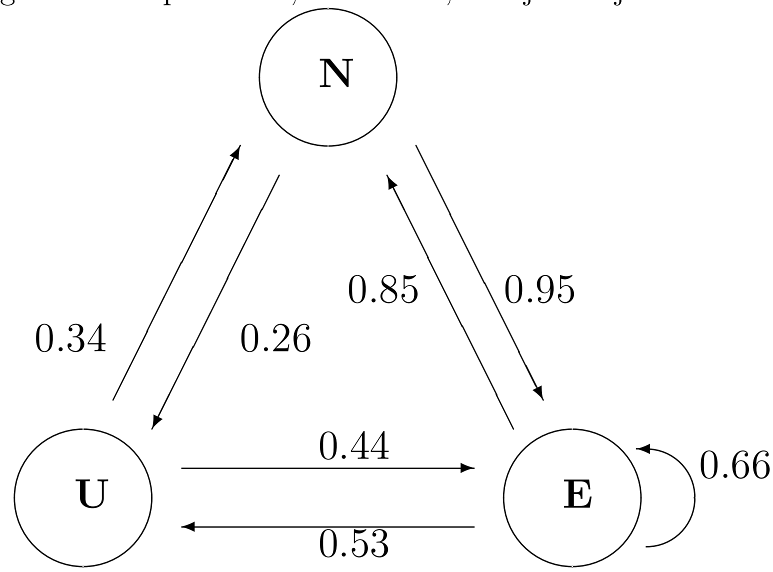
3.4.1 The Overall Picture

In the following, seven different flows are considered: six flows between the three labour market states, and job-to-job flows. As the data are right-censored, I only consider the time period up to 2000:12. Otherwise, one would obtain too many exits into non-registration which are only observed because there are no observations beyond the year 2001. Averages for the time period 1980:1 - 2000:12 for the flows normalised by the labour force are depicted in Figure 3.1. “U” denotes unemployment, “N” non-participation as defined above, and “E” employment.

The figure gives an indication of the respective magnitudes and of the relative importance of the different flows.[11] Note that one can interpret the

[11]Inflows not equalling outflows for a given state are due to the fact that the stocks are

Figure 3.1: Separations, accessions, and job-to-job transitions



Source: IABS-R01 and author's calculations.
Notes: E, U, and N stand for the labour market states of employment, unemployment, and non-participation (see text for further details). The flows are monthly averages normalized by the labour force, and are expressed in per cent.

numbers in the figure as the probabilities of a worker in the labour force (i.e. employed or unemployed) of making a certain transition within a given month. As one can see, flows between employment and non-participation are the most important quantitatively. Very close in order of magnitude are direct job-to-job transitions. Flows between employment and unemployment, on which most of the theoretical search and matching literature focuses, only come third. Finally, flows between unemployment and non-participation are relatively small. These figures are roughly in line with the ones reported in Burda and Wyplosz (1994). The main difference is that I find slightly higher flows between employment and non-participation. This is mainly due to the fact that the third state I consider, non-participation, differs from the usual definition of "out of the labour force" (OLF).

Table 3.1 gives the probabilities, or hazards, of making a certain transition within a given month for the time period 1980-2000. The results show

not constant over time.

Table 3.1: Monthly transition probabilities across labour market states for 1980-2000

		Destination			
		Same employer	New employer	Unemployed	Not registered
Origin	Employed	97.7	0.8	0.6	0.8
	Unemployed	-	7.1	88.5	4.4

Source: IABS-R01 and author's calculations.

that 97.7% of those employed full-time at the beginning of a given month stay with their old employer within that month. 0.8% of the employed switch directly to a new job, 0.6% become unemployed, and 0.8% leave the system of social security within a given month. As for the unemployed, 7.1% find a job, 88.5% remain unemployed, and 4.4% leave to non-registration within a month. These hazard rates reveal large differences to the US labour market, especially for the unemployed. According to Fallick and Fleischman (2004), 93.4% of US employees stay with their employer in a given month, and 1.3% become unemployed. As for the unemployed, however, 28.3% of the unemployed find a new job within a given month, and only 48.4% remain unemployed. Clearly, the latter figure is much lower than the German one. While this is partly due to different definitions of who qualifies as unemployed, the lower dynamics of the German labour market are to be held responsible as well.

3.4.2 Cross-sectional features of hirings, separations, and gross worker flows

Consider first the cross-sectional features of separations and of the flows making up separations, namely the flows from one job to another (EE flows), from employment to unemployment (EU flows), and from employment to non-participation (EN flows). Monthly averages of separations and its underlying flows for the time period 1980-2000 and for different worker categories are reported in Table A.3.[12] The categories considered are age and sex, as well as the industry, the educational background, and the working time (part time or full time) of a worker. For all categories except the age category, I concentrate on the prime age labour force (25-55). For every category, separations are computed as share of the employment stock, and the flows are computed both as share of the employment stock and as share of the total number of separations. Several features are worth noting. First, there is a general tendency of separations to decline with age. This can be justified by the accumulation of job-specific human capital on the one hand (cf. Pissarides, 1994), and learning about match quality on the other hand (cf. Jovanovic, 1984). The only exception is the oldest age group, where separations rise again. As this is mainly due to an increase in flows into non-participation, this is clearly linked to retirement decisions. Also, note that the increased flow into unemployment in the older age group can be seen as a from of (hidden) early retirement. The youngest age cohort features important inflows into non-participation as well. This is in all likelihood due to workers returning to the education sector. As the analysis here is not concerned with life-cycle choices linked to education and retirement, I restrict the following analysis to prime-age workers, defined as workers aged between 25 and 55.

The sex of a worker also has an impact on the likelihood of separation. A male worker is less likely to separate from his employer in a given month. This is mainly due to the fact that women experience less direct job-to-job movements, but instead transit more often from employment to non-participation. I put this down to the fact that women more often leave the labour market in order to raise children. Working in a specific industrial sector also influences the likelihood of separation. As one can see from the table, separations are highest in the construction sector, with the flows between employment and unemployment being of particular importance. The most likely reason for this is that workers in this sector are laid off during seasonal downturns,

[12]The figures for accessions (not reported here) are very similar. This means that the results are not driven by a long-term rise or decline of a specific worker group.

receive unemployment benefits during their spell of unemployment, and are re-employed again thereafter. Unsurprisingly, turnover is particularly low for government employees.

The type of degree a worker holds also plays an important role for the kind of separation she is likely to experience. Workers with relatively low skills, namely those without vocational training (with or without a high-school degree) have a high risk of experiencing a separation, in which case they face a high probability of unemployment or non-participation. Workers who have accumulated more specific human capital through, e.g., a vocational training or a degree at a polytechnical university, are more likely to have a new job lined up upon separation. Comparing these results with the ones reported by Nagypál (2004) for the United States reveals that the differences in separation probabilities between education cohorts are generally less pronounced in Germany than in the United States.[13]

Finally, separations are also affected by the type of contractual working time arrangement. Full-time employees have a much lower probability of separating from their employer than part-timers. This means that full-time jobs are more stable than part-time jobs. The type of separation a worker is likely to experience is also very different. Employees working full time are much more likely to experience a direct job-to-job transition than to drop out of the social security labour force. For part-time employees, the opposite is the case. Thus, part-time employees are more likely to leave social security employment than to move to a new job covered by social security legislation.

Summarising the above results, it is evident that worker characteristics play an important role in determining aggregate flows in the economy. As the composition of the workforce might change over the business cycle, these heterogeneities have to be taken into account when analysing the cyclical features of worker flows. This is explicitly done in section 3.5. First, however, I compute the stylised business cycle facts of worker flows in Western Germany.

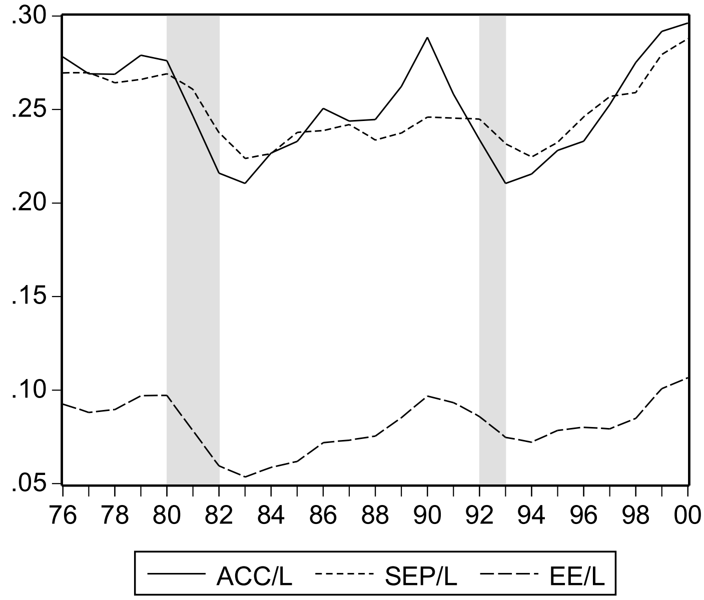
[13]See Fitzenberger and Kohn (2006) for a related result. They find that the substitution elasticities between employees in different skill groups are lower in Germany than the elasticities in the US reported by Katz and Murphy (1992) and Card and Lemieux (2001).

This is done by implicitly assuming that all workers are homogeneous.

3.4.3 Hirings, Separations, and Gross Worker Flows Over the Cycle

I now use the spell information on individual workers to construct time series for the different flows. As I show later, there is no clear trend in the data. The following analysis therefore focuses on the cyclical features of the flow series. I start by examining the evolution of separations, accessions, and employer-to-employer movements over the cycle. The evolution of these flows for the time period 1975-2000 is depicted in Figure 3.2. Separations are

Figure 3.2: Separations, accessions, and job-to-job transitions



Source: IABS-R01 and author's calculations.
Notes: ACC are accessions, SEP separations, and EE direct job-to-job transitions; L is the labour force as defined in the text. All flows are cumulatively calculated and expressed per annum. Shaded areas are times of recession.

calculated as the sum of all matches that split up during a given year, i.e. the flows going from one job to another (EE flow), into unemployment (EU), or into non-registration (EN). Accessions are calculated as the sum of the flows going to employment from any possible state of origin, i.e. from employment (EE), from unemployment (UE), and from non-participation (NE). Again, I normalise all the flows by the labour force. The shaded areas in the graph mark the dates of the beginning (business cycle peak) and the end (business cycle trough) of a recession. The peaks of the German business cycle are in $80/I$ and $92/I$, and the troughs are in $82/IV$ and $93/IV$. As one can see, separations are much flatter than accessions over the cycle. As expected, accessions decline during recessions. This is partly a consequence of the drop in direct job-to-job transitions shown in the graph. Surprisingly, however, separations *decline* during recessions as well, i.e. there is clearly no increase in match break-ups. The evolution of the three flows is thus consistent with a shift of job-to-job transitions to employment-to-unemployment transitions in a recession. This evidence therefore provides support for the hypothesis that recessions go along with a decline in hiring activity, rather than a burst in match separations. I investigate this hypothesis further by looking at the flows that make up hirings and separations.

The worker flows for the time period 1980-2000 are depicted in Figure A.8.[14] First of all, it is worth noting that there is no clear trend in the data, i.e. worker turnover in the economy does not seem to have changed much during the time period considered.[15] In terms of volatility, however, there are marked differences between the flows. Table A.4 contains the means, standard deviations, and the relative standard deviations of the different flows. Job-to-job flows turn out to be by far the most volatile ones, followed by the flows from non-participation to employment and the flows between employment and unemployment. Table A.5 depicts the contemporaneous correlations of the different worker flows with the GDP growth rate. As one can see, job-to-job flows are clearly procyclical, as are flows from non-participation to employment, and the flows between unemployment and non-

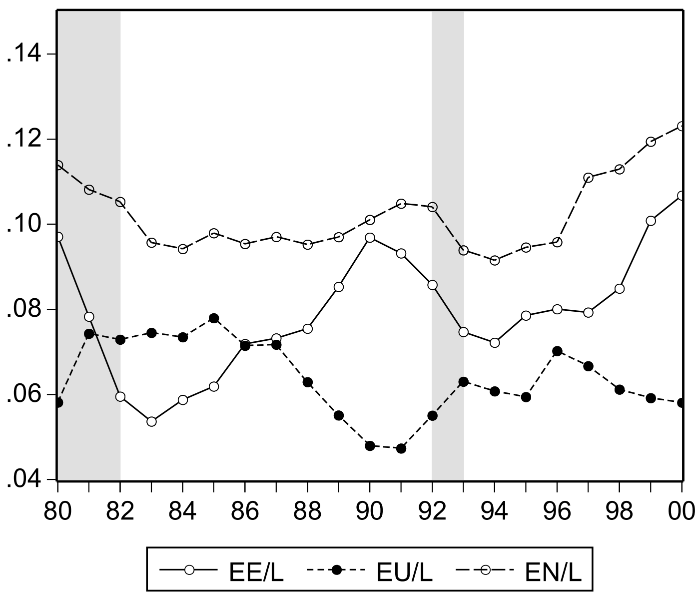
[14] As noted above, the records on the origin and destination of workers entering or leaving the state of employment before 1980 are incomplete and are therefore discarded.

[15] However, gross flows seem to be rising from the mid-1990s. Whether this is a long-run trend will only become clear once more data are made available.

participation. The flow from employment to non-participation, as well as the flows between employment and unemployment are countercyclical. These results are in line with other research (cf. Mortensen and Pissarides, 1999a).

I now turn to the flows making up accessions and separations. The latter are depicted separately in Figure 3.3. From this figure, the cyclical fea-

Figure 3.3: The evolution of the worker flows making up separations, 1980-2000



Source: IABS-R01 and author's calculations.
Notes: EE are direct job-to-job transitions; EU and EN are transitions from employment to unemployment and to non-participation, respectively. L is the labour force as defined in the text. All flows are calculated on a cumulative basis and expressed per annum. Shaded areas are times of recession.

tures discussed become apparent again: the flow from employment to unemployment is strongly countercyclical, the flow from employment to non-registration is procyclical, as is the flow from employment to employment. Summing over these flows (EU+EE+EN), one gets a relatively acylical time series, i.e. total separations. These various flows are caused by very different mechanisms. It seems fair to say that the majority of workers that transit from employment to unemployment do so involuntarily - if this is true, then one can associate the EU flow more or less accurately with layoffs.[16] On the other hand, EE flows are to a great extent caused by workers engaging in job-shopping - these flows are therefore in large part voluntary, and one can associate them with quits.[17] The picture one gets about separations and the underlying worker flows is thus consistent with the explanation that during a recession, the number of layoffs rises while the number of quits falls, leaving overall separations relatively unaffected. Davis et al. (2006) present direct evidence that this is the case on the US labour market, as does Erlinghagen (2005) for western Germany using the SOEP data. The indirect evidence in the present paper confirms this statement for the German labour market. It is also underlined by the fact that the contemporaneous correlation between the EU and the EE flows is negative and strong (see Table A.6).

The above analysis shows that the *level* of separations is relatively flat over time. However, its *composition* is subject to important variations. This in turn has important implications for labour market dynamics and outcomes. As described in the introduction, this is for example the case because of the role job-to-job transitions play for the evolution of match quality over the cycle (cf. Barlevy, 2002). Thus, this composition effect should be taken into account in the modelling of the dynamics of worker flows over the business cycle. Furthermore, this effect is likely to be important in other contexts as well. It is, e.g., conceivable that changes in labour market institutions do not have a level effect on flows, although they have a composition effect. This could be the case for changes in firing costs. To take a specific example, Bauer et al. (2007) scrutinize the effects of changes in dismissal protection in small establishments on worker turnover. Interestingly, they find that such changes did not have significant effects on the hiring and firing behaviour of the affected firms. However, they only look at separation rates, hiring rates, and job flow rates, and do not analyse the underlying worker flows separately. Therefore, a fall in quits and an increase in firings which leaves

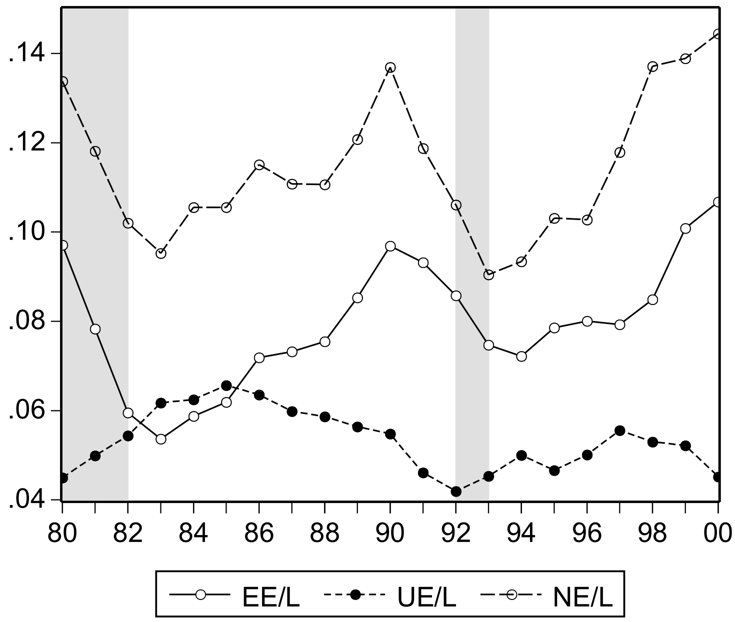
[16]Note that some workers might voluntarily quit into unemployment.

[17]Dismissals with advance notice might lead to direct job-to-job transitions. Given the strong procyclicality of EE flows, this factor only seems to have a limited influence here.

overall separations unchanged might go unnoticed. The present analysis suggests that this might well be the case.

The different flows that make up accessions are depicted in Figure 3.4. Both from this figure and from Tables A.5 and A.6 two important differences

Figure 3.4: The evolution of the worker flows making up accessions, 1980-2000



Source: IABS-R01 and author's calculations.
Notes: EE are direct job-to-job transitions; UE and NE are transitions from unemployment and from non-registration to employment, respectively. All flows are cumulatively calculated and expressed per annum. Shaded areas are times of recession.

between the flows making up accession and the flows making up separations become apparent. First, the flow from non-participation to employment is more strongly influenced by the business cycle than the flow in the opposite direction. Second, the contemporaneous correlation between the EE flow and the UE flow (which are part of accessions) is much weaker than the contemporaneous correlation between the EE flow and the EU flow (which are part of separations), i.e. the UE flow is less responsive to the business cycle than the EU flow. One explanation for this is the time-consuming nature of the matching process in the labour market.[18]

It is worth noting that the stylised facts computed above for worker flows that are normalised by the labour force are consistent with some well-known facts about different hazard rates - i.e. worker flows divided by the state of origin (cf. for example Machin and Manning, 1999). I depict the hazards of flowing from employment to unemployment and vice-versa in Figures A.10 and A.11, respectively. Two observations are in order. First, the hazard of transiting from employment to unemployment is strongly influenced by the business cycle and does not show a trend. Second, the hazard of transiting from unemployment to employment is mainly dominated by the evolution of the unemployment rate. This can be seen from the fact that the hazard declines in recessions, while the normalised flow from unemployment to employment rises. The reason for this is as follows. In a recession, the *absolute* number of transitions from unemployment to employment rises, because many workers who lose their job in a recession quickly find a new one. At the same time, the stock of unemployment rises, and does so more quickly than the the absolute number of UE transitions. Therefore, the hazard rate of exiting unemployment ($ue_{t+\tau}/u_t$) falls in a recession. The normalisation by the labour force ($ue_{t+\tau}/(e_t + u_t)$) yields a different result because the labour force does not change significantly during a recession. Therefore, the evolution in UE transitions thus normalised is dominated by the evolution of the absolute number of UE transitions. The UE flow normalised by the labour force thus rises in a recession. The stock of unemployment dominating the hazard of exiting unemployment also plays a role for its long-term evolution: over the time period considered, this hazard features a strong level effect. Unemployment increases in a stepwise fashion after each of the two recessions in the time span considered, while the absolute number of transitions from unemployment to employment is relatively stable (compared to the stock of unemployment). This implies a reduction in the probability of making such a transition, and a concomitant increase in the overall duration

[18]See Fahr and Sunde (2006b) for a recent analysis of the matching process in Germany.

of unemployment.

Finally, it is worth pointing out the importance of calculating the transitions cumulatively, i.e. of *not* doing a points-in-time comparison in order to calculate flows. To do so, I decompose the flow from unemployment to employment into different duration classes. This means that I calculate the number of workers who have been unemployed for a certain period of time and transit to employment, and divide this number by the total number of workers flowing from unemployment to employment. The result of this exercise is depicted in Figure A.9. As one can see, those workers who have been unemployed for less than 7 days and who become employed in a given year account for only a small fraction of all unemployment to employment flows (5%). The unemployment duration class of less than 30 days makes up nearly 20% of all unemployment-employment transitions. And for the less than 90 days duration class, the corresponding figure is already higher than 40%. This shows that relatively short unemployment spells play an important role in the dynamics of the German labour market. Therefore, length-biased sampling is likely to be an important problem if points-in-time comparisons are used.[19] The reason for this is that a large number of transitions going to or originating from spells characterised by short durations will be missed. This is especially true when the reference dates are far apart from each other.

3.5 Worker Heterogeneity, Flows, and the Cycle

Descriptive Evidence

While the above discussion implicitly assumed that workers are homogeneous, I now explicitly take into account worker heterogeneity. This is important because, given the cross-sectional features of separations and of the under-

[19]Cf. Kiefer (1988) for a discussion of this issue.

lying worker flows, the above results could derive from composition effects which are due to the business cycle. For example, young workers might be more likely to lose their job during a downturn than older workers, which would influence the aggregate results. As I want to concentrate on the core labour force, the following analysis only considers workers who are between 25 and 55 of age, and who work in a full-time job.

I follow Nagypál (2004) and decompose the process of becoming unemployed in the following way: denote the labour market state by s, let subscripts i and t denote a person and point in time, respectively, and let $P^j_{it+\tau}$ be the probability of event j happening to person i during time period $[t, t+\tau]$. Furthermore, let S be the event of a separation, LF the event of staying in the labour force conditional on having been employed, but having separated from the employer. Finally, let superscript U denote the event of becoming unemployed conditional on having been employed, having separated from the employer, and having stayed in the labour force upon separation. Then the probability of a transition from employment to unemployment, EU, can be decomposed as follows:[20]

$$P^{EU}_{it+\tau} = P^S_{it+\tau} P^{LF}_{it+\tau} P^U_{it+\tau} \tag{3.3}$$

with

$$\begin{aligned}
P^{EU}_{it+\tau} &= P(s_{it+\tau} = U | s_{it} = E) \\
P^{S}_{it+\tau} &= P(\text{separate from employer during period } [t, t+\tau] | s_{it} = E) \\
P^{LF}_{it+\tau} &= P(\text{stay in LF}|\text{separate from employer} \\
&\qquad\qquad \text{in period } [t, t+\tau]|, s_{it} = E) \\
P^{U}_{it+\tau} &= P(s_{it+\tau} = U|\text{stay in LF, separate from employer} \\
&\qquad\qquad \text{in period } [t, t+\tau], s_{it} = E),
\end{aligned}$$

with $\tau \in [0, 1]$. Note that these formulae respect the fact that transitions are recorded cumulatively. Also, it is important to realise that this decom-

[20] A graphical representation of this decomposition can be found in Figure A.12 in the appendix.

position does not imply a sequential timing of events. Instead, it simply calculates the different conditional probabilities involved in the process of becoming unemployed during a certain time period.

I start by applying this decomposition to explicitly calculate from the data the three conditional probabilities involved.[21] In doing so, I use the fact that with the large number of observations at hand, the sample means equal the respective probabilities. For example, the probability that an employed person who is randomly drawn from the sample will separate from his employer during a given month is given by the size of the separation flow divided by the number of people employed. I thus get a time series from 1980-2000 for each of the three probabilities. Table 3.2 provides some descriptive statistics of these time series, namely the mean, the variance, and the relative variance, i.e. the variance divided by the mean. For the purpose at hand, the latter

Table 3.2: Descriptive statistics for the conditional probabilities.

	P(S|E)	P(LF|S)	P(UE|LF)
$\overline{x}$	26.5	58.3	44.8
$SD(x)$	1.8	1.4	7.5
$\frac{SD(x)}{\overline{x}}$	6.8	2.4	16.7

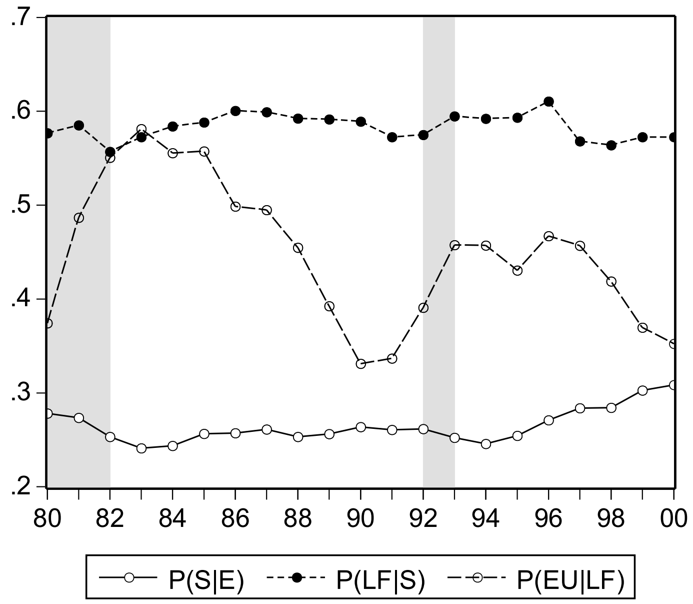
Source: IABS-R01 and author's calculations.
Notes: P(S|E), P(LF|S), P(UE|LF) are the conditional probabilities of separation given employment, of staying in the labour force upon separation, and of becoming unemployed upon staying in the labour force, respectively. $\overline{x}$ is the mean, SD the standard deviation of a probability. All figures in per cent per annum.

statistic is the most important one. It shows that the relative variability of the conditional probability of becoming unemployed is about 17.5 times larger than the conditional probability of staying in the labour force, and about 35 times larger than the relative variability of the conditional prob-

[21] Note that I use the term "conditional" as conditional on the stage of decomposition, not on observable characteristics.

ability of separating from one's employer. This shows that the conditional probability of separating is much less variable that the conditional probability of becoming unemployed. This also becomes evident in Figure 3.5, where the three different time series are depicted. Clearly, the conditional probabil-

Figure 3.5: The conditional probabilities of separation, of staying in the labour force, and of becoming unemployed.



Source: IABS-R01 and author's calculations.
Notes: P(S|E), P(LF|S), P(UE|LF) are the conditional probabilities of separation given employment, of staying in the labour force upon separation, and of becoming unemployed upon staying in the labour force, respectively.

ities of separation given employment and of staying in the labour force upon separation are quite stable. This stands in stark contrast to the probability of becoming unemployed, conditional on having stayed in the labour force upon separation. The latter probability is extremely volatile over the sample period considered. Here, the business cycle influence appears much more important than for the other two probabilities, with the probability reaching lows at the time of business cycle peaks in 1980 and 1991, and hitting highs at the time of business cycle troughs in 1982/3 and 1993. The probability of becoming unemployed upon staying in the labour force jumps by nearly 50% in both recessions. This is a large effect, especially when compared with the business cycle responses of the other probabilities.

One can also look at different worker groups when calculating the probabilities. I do this for the conditional probability of separation.[22] Figure A.13 depicts the results for employees with different education levels, and Figure A.14 shows the results for employees working in different industrial sectors. For very few of the sub-groups considered is there a burst in separations. Thus, the results obtained from the aggregate evidence about separations do not appear to be driven by composition effects.

Econometric Analysis

Up to now, the results have been purely descriptive, in that I have calculated the different probabilities by looking at their sample means. I now estimate the decomposition stated in Equation 3.3 in a panel data model which will allow me to explicitly take into account the influence on the probabilities both of the business cycle and of individual worker characteristics. To do so, I use a logit specification of the form

$$Pr[y_{it} = 1 | x_{it}, \beta, \alpha_i] = \Lambda(\alpha_i + x_{it}'\beta), \qquad \Lambda(z) = e^z/(1 + e^z),$$

where y is the binary outcome variable which only takes on the values 0 and 1, x includes the explanatory variables, β and α are coefficients, $i = 1, ..., N$ and $t = 1, ..., T$ indicate individuals and time periods, respectively, and $\Lambda(z)$ is the logistic cumulative distribution function. This formulation is very general in that it allows for the presence of time-invariant individual-specific effects, as well as for possible correlations between these effects and the error terms. Unfortunately, this model is subject to the incidental parameters problem, which means that it is not possible to estimate the α_i consistently with T

[22] I did this for the other conditional probabilities and worker groups as well, which yields similar results. The latter are obtainable from the author upon request.

fixed and $N \to \infty$.[23] Given the number of cross-sectional observations in the data set, this clearly is an issue here. There are several ways around this problem. First, if fixed effects are not present, then one can obtain consistent estimates by simply using a pooled binary model with $Pr[y_{it} = 1|x_{it}] = F(x'_{it}\beta)$, where F is a cumulative distribution function. If fixed effects are present, however, this will lead to inconsistent results. Second, one can assume that the individual-specific component of the error term is normally distributed with mean zero, i.e. $\alpha_i \sim N(0, \sigma^2_\alpha)$. This yields the random effects model with likelihood function

$$f\left(y_i|X_i, \beta, \sigma^2_\alpha\right) = \int f\left(y_i|X_i, \alpha_i, \beta\right) \frac{1}{\sqrt{2\pi\sigma^2_\alpha}} \exp\left(\frac{-\alpha_i}{2\sigma^2_\alpha}\right)^2 d\alpha_i,$$

where $f\left(y_i|X_i, \alpha_i, \beta\right)$ is the conditional density of the ith observation. This log-likelihood can be maximised in order to estimate the model.

Third, one can use the conditional maximum likelihood estimator in order to estimate the fixed effects model. As shown by Chamberlain (1980), it is possible to eliminate the α_i from the likelihood function by conditioning on $\sum_t y_{it}$. The drawback of this approach is that it is not possible to condition on $\sum_t y_{it} = 0$ or on $\sum_t y_{it} = T$, which means that one cannot use individuals for which $y_{it} = 0$ or $y_{it} = 1$, $\forall t$. In other words, only individuals for which both outcomes are observed can be considered. This can imply considerable loss of information, and induce a selection problem. Furthermore, time-invariant variables have to be dropped from the estimation. The ensuing conditional density is that of a conditional logit model, with invariant parameters, and regressors varying over alternatives:

$$f\left(y_i|\sum_t y_{it} = c, x_i, \beta\right) = \frac{\exp\left(\left(\sum_t y_{it}x'_{it}\right)\beta\right)}{\sum_{d\in B_c} \exp\left(\left(\sum_t d_{it}x'_{it}\right)\beta\right)},$$

where the set $B_c = \{d_i| \sum_t d_{it} = \sum_t y_{it} = c\}$ is the set of all possible sequences

[23]The following discussion draws on Baltagi (2005), ch. 11, Cameron and Trivedi (2005), ch. 23, and Wooldridge (2002), ch. 15.

of 0s and 1s for which the sum of T binary outcomes $\sum_t y_{it} = c$. Calculating the *marginal effects* emanating from this model is not straightforward. The problem is that the marginal effects of the explanatory variables depend on the fixed effect as well. As the latter can not be estimated directly, one has to make an assumption about the value of the fixed effect in order to be able to calculate the marginal effect.

It is possible to test for unobserved heterogeneity in two different ways. First, one can use a simple likelihood-ratio test in order to assess whether the pooled model or the random effects model is more appropriate. Second, one can test whether the fixed effects model is preferred to the pooled model. In the latter test, under the null hypothesis of homogeneity, both estimators are consistent, but the maximum likelihood estimator from the pooled model is more efficient. Under the alternative hypothesis of fixed individual effects, the former estimator is inconsistent, while the latter is consistent and efficient. It is therefore possible to conduct a Hausman-type test. This test is based on the difference between the conditional maximum likelihood from the Chamberlain estimator and the pooled logit maximum likelihood estimator. The test statistic is asymptotically χ^2 distributed with k degrees of freedom and is given by

$$H = (\hat{\beta}_{CML} - \hat{\beta}_{PML})'(\hat{V}_{CML} - \hat{V}_{PML})^{-1}(\hat{\beta}_{CML} - \hat{\beta}_{PML}).$$

and $k = rank(\hat{V}_{CML} - \hat{V}_{PML})$. For the present logit specification, it is however not possible to test whether the random or the fixed effects model is appropriate. The reason is that the two econometric models are estimated using two different populations which is due to the fact that the Chamberlain estimator only uses a subset of the data. Therefore, the likelihood functions are not comparable, and neither a likelihood ratio test nor a Hausman-type set-up can be used to discriminate between the two specifications.

I now run three different regressions for each of the transition probabilities. As explanatory variables, I include quarterly indicators, as well as indicator variables for education, age cohorts, industries, sex, duration cohorts (quarters on the job before separation), and the aggregate GDP growth rate. Furthermore, in order to be able to run a panel data regression, I transform the spells in the data set to quarterly observations. I do this by attributing the state of employment (unemployment) to a person in quarter I/II/III/IV if she is employed (unemployed) on the 15th of February/May/August/November. Unfortunately, due to limited computational capacity, I can only run the regressions for 25% of the original sample, which I choose at random. I then calculate the different transitions from changes in state from one quarter to the other.

The regression results are in tables A.7, A.8, and A.9. Each table contains the results from the three specifications, the pooled model, the random effects model, and the fixed effects model. The first point to note is that the results from the descriptive evidence are confirmed by the regression results. For all three specifications, the coefficients on the GDP growth rate feature a positive sign for the probability of separating, and of staying in the labour force. This is in line with the descriptive evidence and with the expectation that a business cycle upswing leads to an increase in separations, and to a higher probability of leaving the labour force. However, as for the probability of leaving the labour force upon separation, the coefficient on the GDP growth rate is statistically not significantly different from zero even at the 10% level of significance in either of the three econometric specifications. This means that business cycle swings do not play a significant role for the conditional probability of moving out of the labour force. Looking at the influence of the business cycle on the conditional probability of separation, one can see that the coefficient of the GDP growth rate is significant only at the 10% level in the pooled model and in the random effects model, and it is significant at the 5% level in the fixed effects model. Given the sample size of the data set, this is no very strong evidence for business cycle swings to affect either match break-ups or the decision of a worker to stay in the labour force after a match break-up. By contrast, the coefficients on the GDP growth rate in the regressions featuring the conditional probability of becoming unemployed are statistically significant at the 1% level of significance. The negative sign of the coefficient, implies that a business cycle upswing leads to a significant reduction in the probability of becoming unemployed, and that a downturn leads to a corresponding significant increase in this probability. One can rationalise this finding by the line of argument made earlier: the driving force behind the increase in the flow from employment to unemployment is not the increase in separations, but the reduction in vacancies available to workers who have separated from their employer. The results from the logit regression models show that this evolution is clearly related to the influence of the business cycle.

Another point to note is that for the three regressions, all three specifications yield qualitatively similar (although not identical) results. The different coefficients in the three regression models are nearly always the same in the random effects and the fixed effects model. Therefore, it does not seem to play a role for the direction of the effects of the different variables whether one takes correlation between regressors and error terms into account or not. However, it is indeed important to consider unobserved heterogeneity, which is borne out by the fact that the signs of the coefficients in the pooled regressions sometimes differs from the sign of the coefficients of the random effects and the fixed effects regression. This is confirmed by the two specification tests described above. The likelihood ratio test between the pooled model and the random effects model yields a χ^2 value of 1173, which means that the null hypothesis of homogeneity is very strongly rejected. To conduct the Hausman test between the pooled model and the fixed effects model, I run a new regression excluding the time-invariant gender dummy variable and drop the constant in order to calculate the required test statistic. This test very strongly rejects homogeneity as well, with a test statistic of 1957. Thus, both the random effects model and the fixed effects model are clearly preferred to the pooled model. As pointed out above, it is unfortunately impossible to test whether the random effects or the fixed effects model is more appropriate in this set-up.

I next investigate the magnitude of the different effects. As discussed above, one has to make assumptions on the individual error terms in order to calculate marginal effects for the random effects and for the fixed effects logit models. I do so by setting the individual error term equal to zero. The results are reported in Table 3.3. As one can see, the probability of

Table 3.3: Marginal effects of GDP growth

	Pooled	Random effects	Fixed effects
$P(S \mid .)$	-0.0002**	-0.0001***	-0.0008**
$P(LF \mid .)$	0.0006	0.0007	0.0013
$P(U \mid .)$	-0.0117***	-0.0139***	-0.0120***

Source: IABS-R01 and Statistisches Bundesamt.
Notes: P(S|E), P(LF|S), P(UE|LF) are the conditional probabilities of separation given employment, of staying in the labour force upon separation, and of becoming unemployed upon staying in the labour force, respectively. $\overline{x}$ is the mean, SD the standard deviation of a probability. See Tables A.7, A.8, and A.9 for number of observations. Significance levels: *: 10%, **: 5%, ***: 1%.

staying in the labour force does not depend upon the influence of the business cycle at all. In all three specifications, the impact of the GDP growth rate is insignificant even at the 10% level of significance. The other two probabilities, however, are significantly affected. For the conditional probability of separation, this is the case at the 5% level of significance. The conditional probability of becoming unemployed is even significant at the 1% level. Furthermore, the latter probability is an order of magnitude more important than the former, namely by a factor of 58.5 in the pooled model, a factor of 139 in the random effects models, and a factor of 60 in the fixed effects model. Thus, the business cycle has an impact that is 58.5-139 times stronger for the conditional probability of becoming unemployed than for the conditional probability of separating. This confirms and quantifies the previous results. The magnitude of the marginal effect of GDP growth on the conditional probability of becoming unemployed can be interpreted as follows: a 1% reduction of the GDP growth rate increases the probability of becoming unemployed given one has separated from one's employer by 1.1% in the pooled model, by 1.39% in the random effects model, and by 1.2% in the fixed effects model.

3.6 Conclusion

In this paper, I have analysed the dynamics of the German labour market by investigating worker flows along various dimensions. First, I provided both time-series and cross-sectional evidence on these flows. This showed that the flows between employment and non-participation, as well as job-to-job flows, are much more important quantitatively than the flows between employment and unemployment. As pointed out by Burgess (1993), this also has implications for the outflow rate from unemployment, as employed job searchers crowd out unemployed job searchers. Furthermore, worker characteristics play an important role for worker flows. In the main part of the paper, I analysed match separations and accessions, and their underlying flows. I found that, in the aggregate, accessions are more volatile over the cycle than separations. While the latter are relatively flat, the former are clearly procyclical. Therefore, hirings seem to play a more important role for labour market dynamics than separations. This issue was further investigated by decomposing the process of becoming unemployed using a method proposed by Nagypál (2004). This analysis showed that separations are relatively flat over the business cycle also for different worker groups. Therefore, the aggregate results do not seem to be caused by composition effects. Finally, I corroborated the above results by running a panel data logit regression for the three conditional probabilities involved in the probability of making a transition from employment to unemployment. I was thus able to directly show that business cycle swings most strongly affect the probability of flowing into unemployment conditional on having separated from the previous match. The probability of a worker separating from his employer itself seems to be only mildly affected by the business cycle. I concluded that the increased inflow into unemployment in a recession is mainly due to the decline in direct job-to-job transitions, and not to increased match break-ups. The second important point made in this paper is that the changing *composition* of separation flows plays an important role for the dynamics of the labour market over the business cycle. In a recession, direct job-to-job transitions fall while transitions from employment to unemployment rise. This leaves separations relatively unchanged.

The empirical evidence on the relative importance of hirings and separations over the cycle has important implications for the way labour market dynamics should be modelled. As Shimer (2005c) emphasises, the "conventional wisdom" posits that worker flow dynamics are driven by swings in match separations. This understanding of labour market dynamics emanates from the search and matching-type model as epitomised in Mortensen and Pissarides (1994). However, as pointed out above, Mortensen and Pissarides (1999a) acknowledge the fact that separations are relatively flat over the cycle. I would therefore rather describe the Mortensen and Pissarides (1994) model as a good tool for thinking about *involuntary* separations. The latter are however only one determinant of labour market dynamics, the influence of which seems to be very limited. The evidence found both in this paper and in studies for the US labour market point to hirings, rather than to separations, as the central force underlying worker flow dynamics. More attention to models that adequately stress the role of hirings therefore seems to be called for.

The changing composition of hirings and separations over the cycle leads me to another general point: separations (and turnover) can remain constant even though the composition changes. This fact is not taken into account by many empirical studies looking at the effect of changes in firing costs. This omission stems from the conventional wisdom which implies that the level of separations will be affected by such changes. However, it is possible that new labour market regulations of dismissal protection do not have an impact on the level of separations, but nevertheless have important consequences for the composition of the underlying flows - which would lead to very different worker flow dynamics. This implies that studies that look at the effect of dismissal protection by examining overall separations might yield the wrong conclusions. The (policy) conclusions emanating from the “conventional wisdom” might therefore have to be rethought to an extent.

In sum, the results in this paper provide evidence that recessions do not lead to a burst in match separations. The most important influence on labour market dynamics during recessions seems to be the reduction in the hiring activity of firms. This leads both to reduced job-to-job transitions, and to increased inflows into unemployment. This is a challenge to the conventional wisdom about the link between unemployment and recessions. The results of this paper should therefore be of interest to labour economists and macroeconomists alike.

Chapter 4

Sectoral Transformation, Turbulence, and Labor Market Dynamics in Germany

with Michael C. Burda

The secular rise of European unemployment since the 1960s is hard to explain without reference to structural change. This is especially true in Germany, where industrial employment has declined by more than 30% and service sector employment has more than doubled over the past three decades. Using individual transition data on West German workers, we document a marked increase in structural change and turbulence, in particular since 1990. Net employment changes resulted partly from an increase in gross flows, but also from an increase in the net transition "yield" at any given gross worker turnover. In growing sectors, net structural change was driven by accessions from nonparticipation rather than unemployment; contracting sectors reduced their net employment primarily via lower accessions from nonparticipation. While gross turnover is cyclically sensitive and strongly procyclical, net reallocation is countercyclical, meaning that recessions are associated with increased intensity of sectoral reallocation. Beyond this cyclical component, German reunification and Eastern enlargement appear to have contributed significantly to this accelerated pace of structural change.

4.1 Introduction

Modern market economies are constantly subject to structural change. Some sectors shrink, while others grow. Some of these changes are of short duration, reflecting fads, terms of trade, or temporary shifts of technology, while others appear more or less permanent. The most important common long-run trend for developed economies has been a marked shift of employment away from production towards service activities, as predicted by the "three-sector hypothesis".[1] Indeed, with the exceptions of Finland, Ireland, and Sweden, the share of manufacturing in total GDP has declined throughout the European Union over the past quarter century.

It is natural to associate structural change with pervasive gross and net movements of workers between the different sectors of the economy. This expectation is borne out in economic research on labor market flows, and is especially relevant for Germany, in which the share of manufacturing in total GDP declined from 28% in 1980 to 21% in 2005.[2] This development has not been an even one. From 1970 to 1990, manufacturing employment declined from 10.1m to 9.1m, i.e. by 1m or 10%. From 1990 to 2005, it fell further to 6.8m, which corresponds to a drop of 2.3m, or 25%. The growth of service sector employment, by contrast, was much more steady, rising from 6.1m in 1970, to 10.6m in 1990, to 14.5m in 2005. At the same time, unemployment rose from below 2% to over 10%. The German case is important not only because of Germany's size in the European Union and Euro area, but also because of its highly industrialized initial conditions and the marked delay of its transformation when compared with other EU economies.

While earlier influential analyzes of the European unemployment problem stressed the impact of systemic supply shocks of the 1970s (Bruno and Sachs, 1985) or inappropriate constellations of labor market institutions (Layard et al., 2005), most research has dismissed the role of structural change

[1] For the classic references see Fisher (1935), Clark (1940), and Fourastié (1949).

[2] The data in this section are from the OECD STAN Database and Statistische Ämter der Länder (2006).

for the secular rise of European unemployment since the 1970s (for recent summaries, see Nickell et al., 2005 and Blanchard, 2006). Only recently have structural shifts received more attention (cf. Ljungqvist and Sargent, 1998, 2003, 2004, Marimon and Zilibotti, 1998, and Kambourov and Manovskii, 2004). These studies have raised the question whether rising medium- to long-run unemployment could be attributable to diverging sectoral developments, combined with impediments to mobility and the risk of human capital loss during long spells of joblessness. By all accounts, workers are not as easily redeployed across sectors, occupations and locations as commonly-used models would assert.

Research on the roles of gross and net flows in structural change has been limited by the availability of detailed data on individual workers' employment histories. In this paper, we are able to assess both the extent and the dynamics of structural change by using data on individual worker transitions in West Germany during the time period 1975-2001. We do this by computing gross and net worker flows from a large panel data set which covers 2% of the German social security workforce, and by evaluating the extent of occupational and sectoral mobility over this period. We are thus able to identify precisely where structural change is most prevalent in the economy, which workers are most affected, which worker flows contribute most to it, *and how they do so.* Furthermore, we also emphasize the role the business cycle plays for sectoral and occupational worker reallocation.

Our most important and surprising finding is that the *West* German economy has exhibited a marked acceleration in the pace of structural change since 1990. This increase in deindustrialization is evident not only from analyzing the evolution of employment shares derived directly from our data - we use Chow-type tests to show that there is strong evidence of structural instability in the early 1990s - but also from measures of structural change associated with Lilien (1982). To our knowledge, this increase in the massive reallocation of workers has gone unnoticed in the previous literature. At the same time, we find little aggregate shift in the rate of gross worker turnover in the economy, nor do we uncover any significant increase in entropy measures based on sectoral gross turnover rates, until the mid-1990s, which means that the *net* yield from gross turnover increased during this time period. That these structural shifts begin in 1990 strongly suggests that German unification and eastern enlargement affected not only the new German states, but also had significant, persistent implications for the West Germany economy.

We then proceed to examine in more detail the source of this increase in net flows given gross flows. We begin by computing raw sectoral and occupational mobility rates as reported for the United States by Kambourov and Manovskii (2004). The German case offers an interesting contrast to the US, because occupational training in Germany is delivered by a pervasive apprenticeship system. While overall sectoral and occupational mobility in Germany did not increase significantly until the mid-1990s, important differences exist in these rates across age groups. Moreover, mobility patterns differ significantly between sectors which are expanding (such as services) and those which are contracting (such as manufacturing): net growth in employment in expanding sectors tends to represent workers coming from outside the labor force, while declining sectors tend to release workers into unemployment. Furthermore, growing sectors increase their employment share via higher inflow rates, not via lower outflow rates. Conversely, shrinking sectors reduce employment via lower inflow rates, not by higher outflows out of employment. We also report on the cyclical variation of these types of mobility. The results suggest that the business cycle plays an important role for the extent of sectoral reallocation in the economy. In particular, gross flows tend to decline in recessions, while net flows tend to rise.

The paper is organized as follows. Section 2 summarizes the theoretical and empirical literature on the linkages between structural change and gross worker flows, in the short and the long run, and presents some summary evidence on Germany and Europe in this context. Section 3 gives a detailed description of the data set used and the calculations employed to generate gross and net employment flows. In Section 4, we present new evidence on the evolution of the sectoral employment structure of the West German economy. The fifth section analyzes the dynamics of structural change by examining gross and net worker flows across sectors. We find that the gross flows results are consistent with the findings of Section 4: since 1990, Germany has experienced accelerated structural change, measured on the basis of a number of indicators. The final section summarizes these results and discusses their implications for theory and policy.

4.2 Theoretical and Empirical Perspectives on Structural Change

4.2.1 Long-run Trends and Structural Change

The long-run evolution of economies from agricultural, then to industrial, and finally to service-based structure is the key prediction of the "three-sector-hypothesis" associated with Fisher, Clark, and Fourastié. Central to most theoretical explanations is an exogenous, persistent divergence in labor productivity growth rates in manufacturing and services, as well as a relatively inelastic demand for services.[3] At the sectoral level, it is natural to think of an economy buffeted by idiosyncratic disturbances which reflect changes in tastes, terms of trade, technologies, or institutional interventions, and empirical evidence tends to support the view that these factors are responsible for long-term movements in unemployment.[4] One of the first models to con-

[3]See Baumol (1967) for theoretical linkages of labor productivity growth differences to the secular development of the size of the service sector. Balassa (1964) discussed these developments in terms of nontraded output. Fuchs (1980) linked these developments to increasing female labor force participation. More recently, Ngai and Pissarides (2005) have studied a multi-sector model of growth with differences in TFP growth rates between sectors to derive conditions for balanced growth. For empirical assessments see Layard et al. (2005), and the recent report by the European Central Bank (van Riet et al., 2004).

[4]Marimon and Zilibotti (1998) decompose employment and labor cost in 11 European countries into country, industry, and temporal influences, and attribute 80% of the long-run differentials across countries and industries in employment growth to sectoral effects. They argue that Spain's very high unemployment in the 1990s was mainly due to the difficulties this economy had with reallocating workers from agriculture to industry. van Riet et al.

sider this in general equilibrium was Lucas and Prescott (1974). Rogerson (1987, 2005) extended this analysis to include multi-sectoral models. In the former, a two-period, two-sector model with permanent sectoral shocks is analyzed. Rogerson (2005) proposes a variant of the Lucas-Prescott model which allows for finitely lived agents and sector-specific human capital. In contrast to Lucas and Prescott (1974), where workers always move from declining to expanding sectors, workers from a declining sector might well end up non-employed. This analysis thus allows for a richer set of worker histories. More recently, Lee and Wolpin (2006) investigate the importance of the costs workers face when switching their sector of employment, as well as the role of labor supply and demand factors in the growth of the service sector. In order to do so, they estimate a two-sector growth model with aggregate and idiosyncratic shocks for the US economy. They find that these mobility costs are large, and that demand side factors, namely technical change and movements in product and capital prices, were responsible for the growth of the service sector.

4.2.2 The Business Cycle and Structural Change

Another, somewhat unsuccessful strand of the macroeconomic literature has linked structural change to business cycle fluctuations. In his seminal contribution, Lilien (1982) associated downturns with periods of high sectoral desynchronization, arguing that sectoral shocks require the reallocation of workers between sectors. Because of the time-consuming nature of the labor reallocation process, frictional unemployment arises, which raises the overall unemployment rate. This hypothesis did not hold up to subsequent analyzes. Abraham and Katz (1986) and Blanchard and Diamond (1989) show that the

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(2004) review the main stylized facts concerning sectoral specialization in the European Union, as well as the changes that have taken place over time. One of their findings is that some countries (notably Finland, Germany, and Sweden) experienced above-average rates of sectoral reallocation in the early 1990s. In their analysis of the service sector employment in the EU-15, D'Agostino et al. (2006) conclude that an efficient sectoral reallocation of labor has been hindered by the inflexibility of the labor market and by the mismatch between workers' skills and job vacancies.

evolution of vacancies is not consistent with the sectoral-shocks explanation. In particular, vacancy data do not show large differences in labor demand between sectors. Without very strong complementarities across sectors, such sectoral shocks cannot be seen as a cause of higher unemployment; rather, sectors merely differ in their sensitivity to aggregate shocks. According to Groshen and Potter (2003), the cyclical sensitivity of different sectors in the US economy has changed over time. They attribute the "jobless recovery" of the years 2001-2003 to the fact that more job losses during the preceding recession were permanent than had usually been the case in previous recessions. This means that structural transformation seems to have impeded certain industries from re-employing workers they had previously shed. Despite a lack of empirical support, the "Lilien Hypothesis" gave rise to further attempts to study sectoral complementarities and their role in the cycle. In a related vein, Caballero and Hammour (1994) endogenized the restructuring decision to allow for endogenous scrapping of capital, implying that recessions are better times for firms to "clean house" and shed unproductive capacity.

While this paper is mainly concerned with sectoral flows, it is related to a more general literature on mobility in the labor market, looking especially at the consequences of worker mobility for individual workers and for the economy as a whole.[5] Voluntary job mobility by individual workers has been extensively analyzed in the job search literature (for an overview of job search, see Rogerson et al., 2005). One of the conclusions related to our investigation is that young workers follow a two-stage search strategy: they first try to find a job in a preferred occupation, and only afterwards decide on which sector they want to work in (See, for example, Neal, 1999). Involuntary job mobility, on the other hand, has been studied extensively in the displaced workers literature (see Hamermesh, 1989, Burda and Mertens, 2001, Kuhn, 2002, and Bender and von Wachter, 2006). Displacement has implications both for

[5] Jovanovic and Moffitt (1990) estimate a structural model with both idiosyncratic and sectoral productivity shocks. They find that, for the US between 1966-1980, while having a lower impact than idiosyncratic factors, sectoral shocks play an important role for gross worker mobility.

future wages and for the subsequent labor market history of workers. These consequences are likely to be more negative when a worker has to change sector or occupation, as this implies the loss of sector- or occupation- specific human capital. Worker mobility thus plays a role for the evolution of the wage structure. As Kambourov and Manovskii (2004) point out, the increase of occupational mobility in the United States coincides with a spreading out of the wage distribution, since occupational change implies a loss of human capital, and hence a wage loss.[6] Finally, worker mobility is also important for the allocation of workers to their most productive use in the economy.

4.2.3 Turbulence and Labor Market Dynamics

Structural change and worker mobility is related to the recent discussion of *turbulence* in the labor market. It must be stressed that there exist a number of different notions of turbulence.[7] First, following Lilien (1982), turbulence could be defined as the increased *net* reallocation of workers between sectors during a period. Second, turbulence may be defined as an increasing instability of employment relationships, i.e. an increase in *gross* worker flows (cf. Farber, 1999). Third, one can define turbulence as an increase in mismatch on the labor market. Layard et al. (2005) look at the mismatch between labor demand and labor supply across economic sectors. This can be measured by examining either sectoral market tightness or sectoral unemployment rates. Similarly, Marimon and Zilibotti (1999) construct a theoretical model where workers have specific skills and firms have specific skill requirements. An increase in the mismatch between skills and skill requirements can be seen as an increase in turbulence. In a related vein, Ljungqvist and Sargent (2004) equate turbulence to the increased loss of human capital while workers are

[6] Note, however, that most of the increase in occupational mobility found by Kambourov and Manovskii (2004) occurs in the early 1970s. This result is thus consistent with Vella and Moscarini (2004), who do not find an increase in occupational mobility, because their analysis only starts in 1976.

[7] Note that there is also evidence on turbulence from outside the labor market. Comin and Phillipon (2005), for example, document that the sales volatility of firms has been steadily increasing since the 1960s.

unemployed, which reduces the incentive to take up a new job. This is especially the case when unemployment benefits are high. Note that this definition only posits a reduced outflow rate from unemployment, but remains silent about all other worker flows.

While there is thus a large literature on the causes and the effects of sectoral change, there seems to be a lack of analyzes which specifically look at the dynamics of this change. The paper closest to our approach is Greenaway et al. (2000) who examine the behavior of net and gross worker flows in the UK over the time period 1950-2000. Their key findings are, first, that gross worker flows do not display a secular trend, and second, that net worker flows, i.e. sectoral reallocation, was higher in the 1970s and 1980s than in any other post-war decade. They also argue that gross worker flows are not indicative of the amount of sectoral reallocation occurring. Instead, they are best seen as an indication of the cost of sectoral reallocation.

There exists some work on occupational and sectoral mobility in Germany. The dynamics of the German labor market were analyzed by Bachmann (2005) using the IAB Regional File 1975-2001. This data set consists of registry data provided by the Institute for Employment Research (IAB) of the German Federal Employment Agency. He finds that worker flows do not display a marked trend over the time period considered, although there is some acceleration in gross flows in the second half of the 1990s. This is consistent with the evidence presented by Winkelmann and Zimmermann (1998), who find no evidence of increased job instability in Germany for the time period 1974-94. Similar findings are reported by Farber (1999) for the US. As for the cyclical features of worker flows, Bachmann (2005) shows that while separations are relatively flat over the business cycle, accessions are strongly procyclical. This points to the fact that hirings play a key role for the dynamics of the labor market. In the US context, this point has been stressed by Hall (2005b) and Shimer (2005a).

Velling and Bender (1994) analyze the cross-sectional properties of occupational mobility for employment covered by social security legislation for the year 1989. They also use registry data provided by the IAB. Their main findings are as follows: occupational mobility depends strongly on worker characteristics such as age, education, and sex. Furthermore, the labor market history of a worker, in terms of both wages and previous transitions, has an important impact on the probability of a change of occupation. Bender et al. (1999b) provide descriptive evidence on both types of mobility for the time period 1985-1995 using the same data set. From this, they conclude that the influence of the business cycle on both series is strong. Furthermore, unemployed workers are found to have become more mobile over the time period considered. Gathmann and Schoenberg (2006) analyze the transferability of specific skills across occupations using the IAB employment sample (IABS) 1975-2001. They find that movers can transfer between 20 and 33% of the value of occupational tenure across occupations. Isaoglu (2006) explicitly analyzes occupational mobility of male employed workers in Germany for the time period 1985-2003 using the German Socioeconomic Panel (SOEP). She estimates probit transition models and concludes that occupational mobility is strongly procyclical and strongly dependent upon individual characteristics.

4.2.4 This Study

Our study is explorative in nature and meant to aid the inductive search process from a wide class of existing models. The empirical approach differs from the work described above in a number of ways. First, we use information on individual transitions in the IAB employment sample (IABS) for the time period 1975-2001 to study aggregate gross and net sectoral worker flows over the period 1975-2001.[8] The main advantages of the IAB data set, which is described in detail below, are that the information is relatively accurate, that the sample size is very large, and that the same workers are followed over a

[8] Unfortunately, the data for the time period after 2001 has not yet been made available for public research.

long period of time.[9] Second, we consider occupational and sectoral mobility for workers experiencing different labor market transitions, namely those who switch to a new job without intervening spell of non-employment, those who were previously unemployed, and those who were not covered by the system of social security beforehand. Third, we consider men and women separately. Finally, this study considers data from Germany, the third largest economy in the world, the largest in the European Union as well as one long beset by chronic unemployment.

4.3 Data and Measurement Issues

4.3.1 The IAB Regional File

The data set used is the IAB Regional File 1975-2001 (IABS-R01), which is generated by the Institute for Employment Research (IAB) of the German Federal Employment Agency. The data base covers 2% of all the persons who worked in an employment covered by social security between the 1st January 1975 (for western German employees) or the 1st January 1992 (for eastern German employees) and the 31st December 2001. The data source consists of notifications made by employers to the social security agencies, which include health insurances, statutory pension schemes, and unemployment insurance.[10] These notifications are made on the behalf of workers, employees and trainees who pay contributions to the social insurance system. This means that, for example, civil servants and self-employed are not included. Overall, the subsample includes roughly 1.3 million people, of which 1.1 million are from western Germany. For 1995, the employment statistics, from which the IAB Regional File is drawn, cover roughly 80% of the employed persons in western Germany, and 86% of all employed persons in eastern Germany. Of the unemployed, only those entitled to unemployment benefits

[9] This is not the case for the CPS, where workers are only followed for four consecutive quarters.

[10] For a complete description of the data set, see Bender et al. (2000).

are covered. This means that the unemployment stock is about one third lower than that reported in official labor statistics.[11] Data observations are generated by notifications which are made at the beginning and at the end of an employment or unemployment spell. Furthermore, there is an annual report which updates some of the information. The information provided is the following: sex, year of birth, and degree of education/training. Also, information on the occupation and the gross earnings of workers, an establishment number, and the economic sector is available on a daily basis. Our notion of a job is based on establishments, not firms, which means that a change of establishment within the same firm will also be recorded as a job change. Employers do not have to notify the social security agency if *only* the sector or the occupation of an employee changes. However, this information must be reported in every mandatory notification, i.e. at the beginning of an employment spell, and at the beginning of every calendar year. As a change of sector always involves a new employment relationship, and thus a new notification, every such change is recorded. This is not true for changes of occupation, as this might well change for an employee while he remains in the same establishment. Therefore, a change of occupation on the same job will only be recorded at the end of the year. This means that some occupational mobility is not recorded, for example when an employee changes his occupation and the match is destroyed before the next annual notification. Thus, we have exact information on sectoral mobility, and a lower bound on occupational mobility. The empirical analysis considers 16 broad economic sectors; 128 different occupations are recorded.

Two states of the labor market can be directly derived from the data set: employment covered by social security, and unemployment, if the worker is receiving some form of unemployment compensation. The third state that we consider, "non-participation", is not directly recorded but is defined as those individuals of working age who do not pay social security contributions while employed, and do not receive unemployment benefits. This means

[11] See Bender et al. (1999a).

that non-participation includes the state “out-of-the-labor-force”, but also self-employment, civil service employment, retirement, or marginal employment. “Non-participation” thus provides an upper bound for “out-of-the-labor force”.[12]

This data set has a number of unique advantages. First, it does not suffer from the problems inherent in most panel data sets, e.g. there is no sample attrition, and it follows workers over a long period of time as opposed to rotation-based samples such as the CPS.[13] Given the length of our times series, the evidence here is likely to be more conclusive than the US studies cited above, which observe only one episode of labor market tightening (1994-2000) and slowdown (2000-2003). Our data set covers two decades and two full business cycle swings. Second, it offers observations at a very high frequency, which means that every actual transition is observed. This is a distinct advantage over survey data like the CPS or the SOEP, which does not record multiple transitions that take place between two interview dates and, in the case of the SOEP, uses retrospective data. Two limitations of the data are noteworthy. First, it is representative for the working population covered by social security legislation, and not the entire working population. Second, it only covers unemployed who receive unemployment benefits. Therefore, this special structure of the data set should be taken into account when interpreting the different flows, especially the ones going to and from non-participation.

4.3.2 Construction of Worker Flows

Given the data on the employment state of workers, there are two possible ways to calculate worker flows. First, one can use point-in-time comparisons. This implies checking the labor force state of each individual at two given dates (e.g. at the beginning of two consecutive months), and inferring the

[12] Cf. Fitzenberger and Wilke (2004b) for an in-depth analysis of this issue.

[13] Technically attrition is possible in the sense of non-benefit recipients and labor force activity in the underground economy.

ensuing flow from this comparison. Second, one can calculate flows cumulatively, i.e. taking into account every change of state that takes place, even if there are several changes of state within a given time period (e.g. a month). As our data record every single move with daily accuracy, we opt for the latter approach. Thus, we take into account short spells as well, which are generally not recorded in other data sets.[14] As it is possible to track the employment and unemployment history of every person in the data set, we can compute the flows to new job matches from different origins. We do so for employer-to-employer (EE) transitions, unemployment to employment (UE) transitions, and transitions from non-participation to a new employment (NE).

We need to address the possibility of measurement errors in the data. In particular, workers' notifications of leaving the state of unemployment might not always correspond exactly to the actual change of labor market state. We correct for this latter potential measurement error in the following way: If the time interval between an unemployment and an employment record is smaller than 30 days, we count it as a direct transition between the two states recorded.[15] If the gap between two notifications is larger than 30 days, we count this as an intervening spell of non-participation. As for job-to-job flows, records that are from the same person and the same establishment are counted as one single spell as long as the time between two consecutive employment notifications does not exceed 7 days.

As we are interested in consistent time series that go back as far as possible, the empirical analysis is restricted to workers from western Germany. As there is no information on the place of residence in the data set, we discard observations on employees that at some point have worked in eastern Germany. We also drop some observations, such as artists, who feature an implausibly high number of spells. As these observations are due to administrative rules, they are not interesting from an economic point of view.

[14]Note, however, the qualification mentioned above with respect to occupational mobility.

[15]Recalculation of spells for shorter intervals does not change the results significantly.

We therefore eliminate all observations for any person who features more than 200 employment spells over the time period considered. We also exclude apprentices. The number of people receiving unemployment benefits is measured with significant error before 1980; consequently, the stock of those workers, as well as the flows from that state, are not used. As employment is correctly measured, we obtain reliable estimates for direct job-to-job transitions for the entire time period 1975 to 2001.

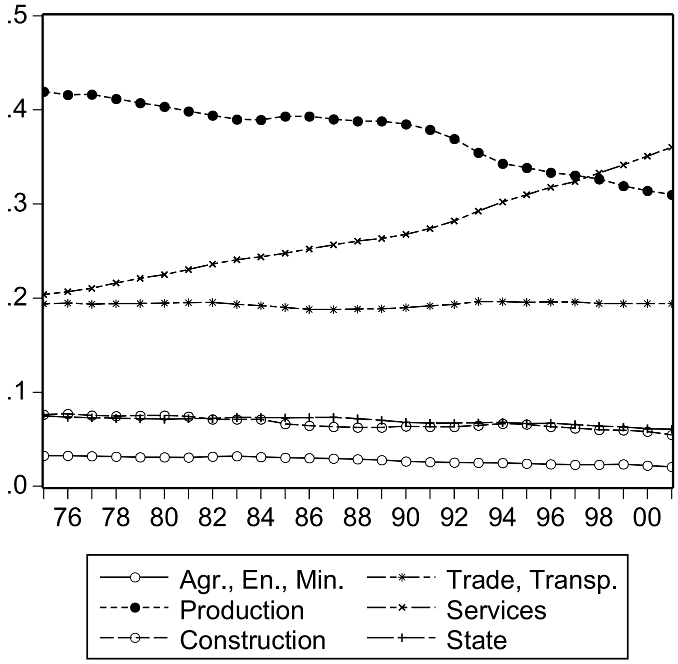
4.4 Findings: Sectoral Employment and Structural Change

4.4.1 The Sectoral Structure of the German Economy

We begin by examining trends in the allocation of dependent status, socially-insured, employment across six main sectors of the economy: agriculture, production, energy and mining, trade and transport, services and government. Dependent-status employment is defined for each year in our sample (1975-2001) as the average of the employment levels on the 15th of every month of that year.[16] The results are displayed in Figure 4.1, which conveys the quantitative importance of the different sectors. For the time period considered, most workers were employed in production, in the service sector, and in trade and transport; construction, agriculture, energy, and mining, and the public sector are quantitatively much less important. The three latter sectors, as well as trade and transport, are relatively stable over time and show little if any pronounced trend. The most striking evolution in the graph is the reduction of the employment share in the production sector, and a concomitant, sharp increase in the size of the service sector. The employment share of services rises by more than 10 percentage points, matched by an equal decline in the production sector's share.

[16] Ideally, one would use beginning or end of year figures. However, due to the particular way in which data is collected in the IAB-data set, we are unable to do so.

Figure 4.1: Sectoral employment shares.



Source: IABS-R01 and authors' calculations.

Sectoral shares of full-time and part-time employment for a finer breakdown of 16 sectors are presented in Table A.11 in the appendix. Over the time period 1975-2001, household-related services remained relatively stable; the employment share of social services, however, increased by over 80%, and the share of business related services more than doubled. As for shrinking sectors, the decline in the employment share is strongest for primary and intermediate goods production (-40%), consumption goods (-41%), and construction (-45%). The main message of this analysis is that over the last decades, an ongoing process of structural change in the German economy has reallocated workers from the production sector to the service sector. Within the service sector, business-related services have increased most, while the share of household-related services has remained relatively constant. Moreover, this process seems to have accelerated since 1990. A natural question to address is whether the reallocation of workers from shrinking to expanding sectors has been smooth, or whether the pace of structural change has accelerated over time. This is the topic of the next section. Another question is: did those workers who have left declining sectors find work in the growing sectors? If so, are they working in the same occupation as before?

4.4.2 Net Structural Change and Turbulence

In general it is difficult to identify or much less measure causal factors behind turbulence. In the first instance, technical change is unobservable; the emergence of technical innovations does not necessarily imply that producers make immediate use of them, or they may do so with a delay. For that reason, economists are forced to study the variance or entropy of observable economic outcomes, for example changes in net employment, unemployment or sectoral value added. Lilien (1982) was among the first to look at the variance of the dispersion of employment growth rates as an indicator of turbulence. He argued that a large fraction of variance of the unemployment rate could be traced to this measure of turbulence. Following Layard et al. (2005) we calculate a turbulence index due to Lilien (1982). The index used takes the form[17]

$$\lambda_{d,t} = \frac{1}{2} \sum_{j=1}^{J} \left| \Delta_d \frac{E_{j,t}}{E_t} \right| . \tag{4.1}$$

Here, J denotes the number of economic sectors considered, $E_{j,t}$ is employment in sector j in period t, E_t is total employment in period t, Δ is the difference operator, and d indicates the number of years over which the difference is taken. Thus, for example, $\lambda_{1,t}$ measures the turbulence at time t as half the sum of changes in sectoral shares from year t to year $t-1$. The division by two is performed in order to avoid double counting. The

[17]The original Lilien (1982) index is defined as
$\sigma = \left[\sum_{j=1}^{J} (\frac{E_{jt}}{E_t})(\Delta \log E_{jt} - \Delta \log E_t)\right]^{1/2}$. The reason for calculating a modified index is that it provides a more natural point of comparison for the flow analysis we are conducting. The two indices yield very similar results. For more discussion and use of this index, see Layard et al. (2005).

evolution of the turbulence index is depicted in Figure 4.2 for six main economic sectors and three differences, namely 1-, 5-, and 8-year differences. As one can see, the indices rise with the amount of difference considered, i.e. the λ_5-index is larger than the λ_1-index, and the λ_8-index is larger than the λ_5-index. This could have been expected as the λ_1-index captures short-run changes (from one year to the next), while the other indices capture more long-run trends. What is striking however, is that all three measures indicate a marked increase in turbulence in the 1990s. Especially the early 1990s seem to have been a particularly turbulent period. This is in all likelihood due to the impact that German reunification had on the labor market of the entire country. But even in the second half of the 1990s, the indices do not return to the previous, lower levels of the 1980s. Neglecting the jump in the early 1990s and comparing the time periods 1985-89 and 1995-99, the means of the three indices increase by at least 85%. This means that this type of turbulence did not abate even more than five years after German reunification.

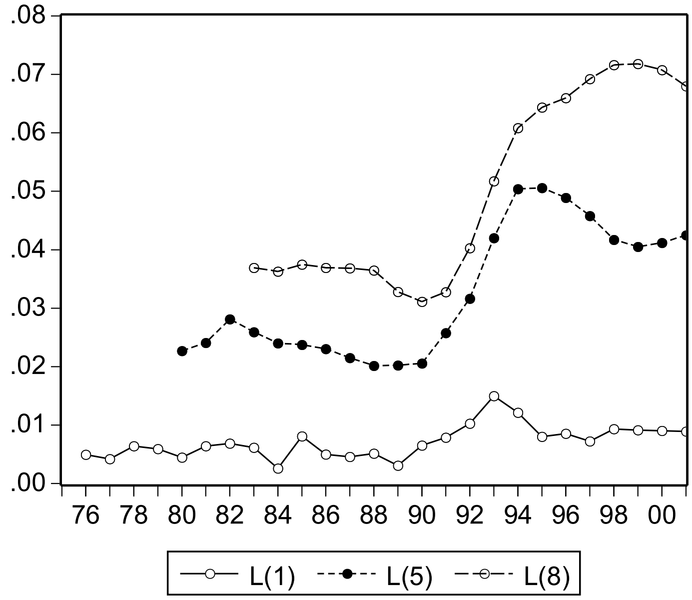
Table 4.1: Turbulence: Lilien index for sectors and occupations, different time periods

	1976-2000	76-80	81-85	85-90	91-95	96-00
Occup. turb., J=10	0.55	0.49	0.56	0.44	0.74	0.57
Sectoral turb., J=6	0.71	0.52	0.60	0.49	1.07	0.87
Sectoral turb., J=16	0.81	0.62	0.72	0.65	1.11	0.94

Source: IABS-R01 and authors' calculations.
Note: The Lilien index is defined in equation 4.1. Results are for $d = 1$.

Our findings for sectoral turbulence for a more detailed sectoral division are in Table 4.1 and in Figure 4.3. As one can see, the results are robust to considering a larger number of sectors: the Lilien indices computed for 16 economic sectors also strongly rise in the early 1990s, and go back in the second half of the 1990s. However, in the latter period they still remain above the levels of the 1980s. The results for turbulence with respect to occupations are in the same table. Similarly to the results for sectors, the Lilien index rises sharply in the early 1990s. Thereafter, however, it returns

Figure 4.2: Turbulence index for different time lags, J=6



Source: IABS-R01 and authors' calculations.
Note: The Lilien index is defined in equation 4.1.

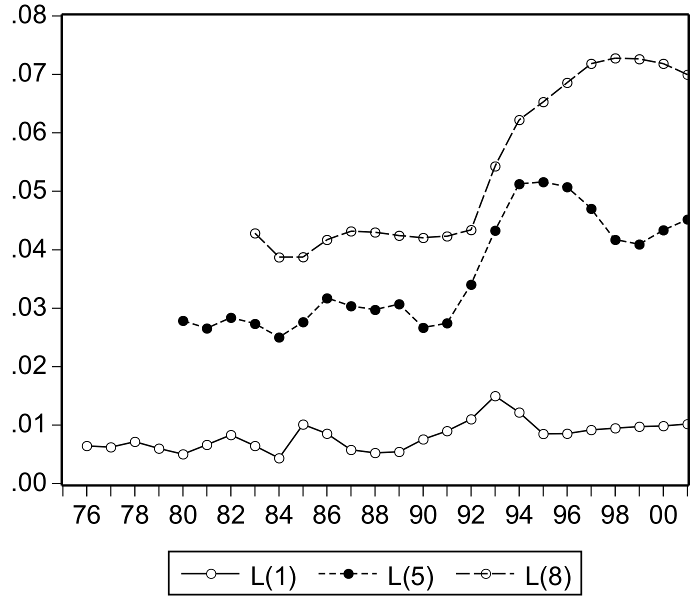
to levels which are similar to those in the 1980s.

To investigate why the sectoral Lilien indices increased in the early 1990s, and why they have remained high thereafter, we rewrite the modified Lilien index in the following way:

$$\lambda_t = \frac{1}{2}\sum_{j=1}^{J}\left|\Delta\frac{E_{j,t}}{E_t}\right| \approx \frac{1}{2}\sum_{j=1}^{J}\left|\frac{E_{j,t}-E_{j,t-1}}{E_t}\right| = \frac{1}{2}\sum_{j=1}^{J}\left|\frac{i_{j,t}-x_{j,t}}{E_t}\right|$$

where $i_{j,t}$ are inflows into and $x_{j,t}$ are outflows from sector j during time period $[t-1,t]$. The approximation holds if the changes in the employment stocks are not too large from one year to the next. Then, it is easy to see that the Lilien index will increase if inflows and outflows diverge. This can happen for two reasons: first, if the short-run variations of inflows and/or outflows increase, and, second, if long-run trends accelerate. In order to examine the

Figure 4.3: Turbulence index for different time lags, J=16



Source: IABS-R01 and authors' calculations.
Note: The Lilien index is defined in equation 4.1.

second possibility, we run regressions of the form

$$y_t = c + at + by_{t-1} + \epsilon_t,$$

where $y_t \equiv \frac{E_{j,t}}{E_t}$ is the employment share of sector j at time t, c is a constant, t a time trend, and ϵ_t an error term.[18] We analyzed these series for structural breaks using the Chow forecast, the Chow sample split, and the Chow breakpoint tests. Using these tests, we analyzed the stability of the above regression for every year from 1980. As the tests are known to have substantially distorted size if the number of observations is small, we use bootstrap versions of the tests in order to size-adjust them (cf. Candelon and Lütkepohl, 2001). The p-values of the three tests for the employment share of the productive sector are in Figure A.15. Given that low p-values

[18]The great majority of employment share series proved to be trend-stationary at least at the 5% level of significance. Because of this, and because of the low power of unit root tests, we treated all time series as trend-stationary.

indicate instability, there is weak evidence for instability in the mid-1980s, and strong evidence for a structural break in the early 1990s, especially for the years 1991 and 1992. The results for the service sector (not reported here) are very similar, with signs of instability already occurring in the late 1980s. We conclude that the year 1990 marks a watershed for the West German labor market: After reunification, the structural change in the economy, i.e. the sectoral reallocation of workers, accelerated significantly.

4.5 More Detail: A Dissection of Mobility and Structural Change

The last section documented significant sectoral shifts in the structure of German dependent-status employment since 1990, but was silent about how structural change actually occurred. For example, from 1990 to 2000, the number of dependent-status workers in the West German manufacturing sector declined from 8.5m to 6.5m.[19] How was this reduction achieved? To answer this question, we need to compute from our data set individual gross worker flows with longitudinal information on the workers in question.

A gross flow can occur for several reasons. A change in labor demand of one economic sector relative to the others gives rise to flows from one sector to another, i.e. net sectoral reallocation. Changes in idiosyncratic productivity of a match can also result in worker flows which at some later data lead to matches in a different economic sector. It is possible to imagine workers "trading places" between sectors - for example if the relative demand for labor at the sectoral level remains unchanged but reallocation of workers turns out to be a Pareto improvement for everyone. Here, a worker flow in one direction implies another in the reverse direction. These two worker movements thus lead to gross reallocation of labor while leaving net reallocation and the distribution of workers across sectors unchanged.

Our analysis proceeds in several steps. First, we examine cross-sectional

[19] Cf. Statistische Ämter der Länder (2006).

and long-run trends in gross worker flows in Section 4.5.1. A detailed analysis of net worker flows can be found in Section 4.5.2, where we investigate the evolution of the components of net flows, as well as the contribution of sectoral inflow and outflow rates to structural change. Finally, in Section 4.5.3, we examine the role of the business cycle for the dynamics of structural change.

4.5.1 Gross Sectoral and Occupational Mobility

First, we examine the cross-sectional properties of the worker flows in the labor market which are associated with a change of sector, occupation, or both. The aim of this exercise is to deliver a general picture of the magnitude of those flows, as well as of the differences between worker groups. Second, we examine the long-run trends of gross worker flows. This will give an indication of whether labor market dynamics have changed over time.

Consider first employment inflows: newly formed employment relationships (accessions) involving a change of sector, or occupation, or both, and distinguish between three different states of origin: employment, unemployment, and non-participation. Effectively, we are looking at flows entailing a change of sector/occupation with workers moving from one employer to another (EE flow) and from unemployment to employment (UE flow). Furthermore, transitions from the state of nonparticipation (technically, non-registration) to employment (NE flow) are analyzed.[20] The analysis is conducted separately for men and women, and for three different age groups, 16-29, 30-49 and 50-65.

The central statistic for our analysis is the rate of incidence of a transition conditional on being in the three states at the outset (employment, unemployment and nonparticipation), measured over a fixed period of time. In doing so we follow, but also extend Kambourov and Manovskii (2004). While

[20] Note that the data set does not contain any information on workers when they are neither in dependent-status employment nor receive unemployment compensation. We are therefore not able to report changes of sector or occupation for EN and NE transitions.

these rates are computed on a cumulative monthly basis (i.e. all transitions are recorded on a daily basis), they will be generally presented as annual averages or averaged over several years. This rate captures the overall level of sectoral or occupational mobility, respectively. As both types of mobility are likely to be related to the type of transition a worker experiences at the same time, we also study the conditional probability of having made a sectoral or occupational transition, given that one particular employment transition has occurred. The rates generated in this way are meant to capture sectoral and occupational mobility *over and above* the movements in worker flows. They can therefore be interpreted as behavioral changes given a certain labor market transition.

Cross-Sectional Results

Table 4.2 provides an overview of different labor force transition probabilities on an annual basis for the time periods 1981-1990 and 1991-2000. Note that the transition probabilities to a new employer or to a new sector are calculated in the cumulative way described above. This means that all transitions are taken into account, also when a worker has multiple transitions within one year. The "no transition" category is calculated as one minus the sum of all transition probabilities. The results show that transitions from employment are most likely to lead to non-participation or to unemployment. The annual probability of a worker experiencing a direct job-to-job transitions is lower, and these transitions more often take place within the same sector rather than involving a change of sector. Workers leaving unemployment are most likely to transit to the state of non-participation. Furthermore, when a worker leaves unemployment, he is more likely to find a job in the sector where he has worked previously rather than in a different sector. Exits from non-participation usually lead to employment, and not to unemployment. Finally, note that these transition probabilities have changed over time, as a comparison between the two time periods considered shows. This issue will be considered in the next section.

Table 4.2: Labor force transition probabilities

		Destination				
		No Transition	Employment, Same Sector	Employment, Different Sector	U	N
Origin	E	74.6 *72.9*	4.1 *5.2*	3.4 *4.0*	7.3 *6.5*	10.6 *11.4*
	U	- -	46.1 *30.3*	34.3 *28.2*	- -	56.9 *54.8*
	N	92.9 *92.6*	- -	5.5 *5.8*	1.6 *1.6*	- -

Sources: Statistisches Bundesamt, IABS-R01 and authors' calculations.
Notes: Figures report transition probabilities for the time period 1981-1990 (first figure for each transition) and for 1991-2000 (second figure for each transition, in italics) in % per annum. E, U, and N stand for the labor market states of dependent-status employment, unemployment, and non-participation.

Next, we analyze differences between age cohorts, and men and women. Table 4.3 shows the unconditional incidence, for dependent status employees, of moving into employment and changing sector at the same time, as well as the probability of changing sector conditional on making a certain type of transition. The corresponding results for occupational changes are presented in Table 4.4.

The rates of incidence are very similar with respect to sectors and occupations. Looking at the differences between age cohorts, one can see that the incidence probabilities are all strongly falling with age. This finding can be rationalized by the fact that young workers, who have only relatively recently entered the labor market, are engaging in job shopping in order to look for the sector and the occupation that suits them best (cf. Neal, 1999). For older workers, this effect is of less importance. Also, older workers have accumulated more sector/occupation-specific human capital. Changing sector or occupation therefore entails a larger loss of human capital for older workers than for younger workers. Hence, the propensity to change sector and occupation is falling with age.[21]

[21] Because sectors are more broadly defined than occupations, the probability of sectoral change is generally lower than that for occupational change.

Table 4.3: Sectoral transition probabilities and fraction of transitions involving a change of sector by age and sex

	Men			Women		
	EE	UE	NE	EE	UE	NE
Age 16-29	6.8	57.0	11.0	5.8	41.9	9.8
	35.3	*50.2*	-	*31.5*	*51.0*	-
Age 30-49	3.8	40.0	4.2	3.0	31.9	5.1
	31.6	*44.7*	-	*30.6*	*47.1*	-
Age 50-64	1.5	11.6	2.1	1.4	9.8	1.5
	34.5	*29.7*	-	*26.1*	*33.7*	-

Sources: Statistisches Bundesamt, IABS-R01 and authors' calculations.
Notes: EE, UE, and NE are transitions from employment, unemployment, and non-participation, respectively, to employment. For EE and UE transitions, the first figure for a cohort reports the average transition probability associated with a change of sector; the second figure (in italics) reports which fraction of a given transition is associated with a change of sector. For NE transitions, information on sectoral mobility is not available; the average transition probability is reported. All figures in % per annum, averages for 1980-2000.

In general, women exhibit lower rates of sectoral and occupational change. This finding is in line with the evidence presented in Fitzenberger and Kunze (2005), who argue that female workers are often locked in low wage careers, characterized by low mobility and for which job changes only lead to small wage gains. The probability of changing sector and occupation is higher when a worker has been unemployed previously than when he experiences a direct job-to-job transition. This implies that direct job-to-job transitions generally take place between jobs involving the same sector and occupation. These results are quite similar for women, with one exception: for women at a young age, direct job-to-job transitions are much less likely to involve a change of occupation than for men.

Long-Run Trends

Let subscript j and t denote an economic sector and time period $[t, t+1]$, respectively. Then, we can compute a measure of gross worker flows

Table 4.4: Occupational transition probabilities and fraction of transitions involving a change of occupation by age and sex

	Men			Women		
	EE	UE	NE	EE	UE	NE
Age 16-29	6.2	58.6	11.0	4.9	41.2	9.8
	31.9	*51.7*	-	*26.5*	*50.1*	-
Age 30-49	3.1	41.9	4.2	2.3	30.9	5.1
	25.8	*46.1*	-	*23.1*	*45.6*	-
Age 50-64	0.9	12.5	2.1	0.8	9.7	1.5
	20.4	*31.9*	-	*14.6*	*33.6*	-

Sources: Statistisches Bundesamt, IABS-R01 and authors' calculations.
Notes: EE, UE, and NE are transitions from employment, unemployment, and non-participation, respectively, to employment. For EE and UE transitions, the first figure for a cohort reports the average transition probability associated with a change of occupation; the second figure (in italics) reports which fraction of a given transition is associated with a change of sector. For NE transitions, information on occupational mobility is not available; the average transition probability is reported. All figures in % per annum, averages for 1980-2000.

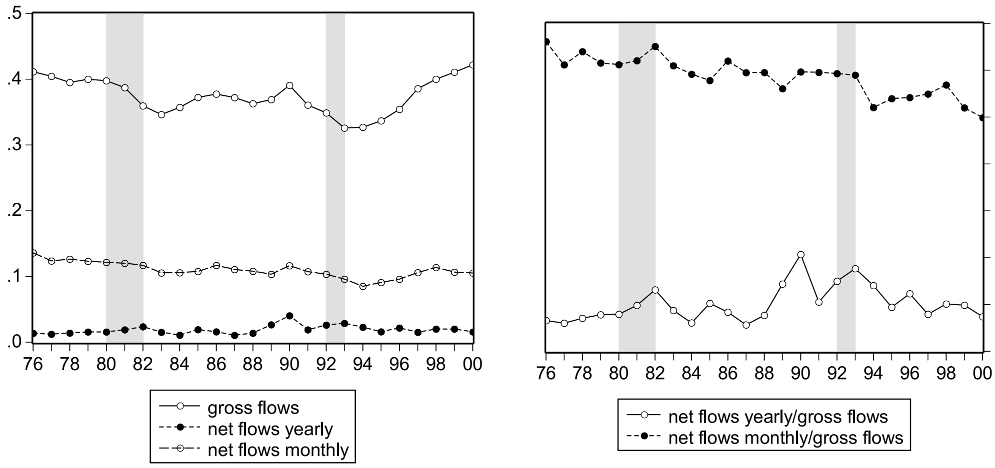
normalized by the labor force as follows:

$$\frac{gross_t}{L_t} = \left[\sum_{j=1}^{J} \frac{1}{2}\left(EEI_{j,t} + EEX_{j,t}\right) + UE_{j,t} + EU_{j,t} + EN_{j,t} + NE_{j,t}\right] \cdot \frac{1}{L_t}$$

where $EEI_{j,t}$ are inflows into and $EEX_{j,t}$ outflows out of a sector j in period $[t, t+1]$ associated with a direct job-to-job transition; UE, EU, EN, and NE are the transitions between the states of employment E, unemployment U, and non-registration N. The "dependent-status (and socially insured) labor force" is defined as $L_t \equiv E_t + U_t$. This measure of gross flows gives an impression of the overall amount of sectoral worker reallocation in the economy. The resulting time series is in Figure 4.4, and averages for different time periods are in Table 4.6 in the appendix. Apart from business cycle fluctuations, the series is quite stable until the mid-1990s, after which it rises sharply.

Next, we analyze the evolution of transition probabilities introduced in

Figure 4.4: Gross and net flows across sectors



Source: IABS-R01 and authors' calculations.
Notes: Net flows on a monthly and a yearly basis normalized by the labor force (left panel), and the ratio of net to gross flows (right panel).

the previous section over time. In particular, we are interested in whether a certain type of transition displays a clear trend. This will cast further light on the questions of whether one can see more turbulence in the labor market as well as inform with respect to the source of turbulence. The analysis is now more detailed and can reveal whether employment relationships have become less stable, whether the unemployed have become more or less mobile over time (which might be an indication of Ljunqqvist-Sargent type turbulence), or whether there have been more or less direct job-to-job transitions involving a change of sector and/or occupation.

Table 4.2 in the previous section shows that there are clear differences between the transition probabilities in the 1980s and the 1990s. First, employment became slightly less stable, with the annual probability of remaining in the same job falling from 74.5% to 72.9%. Second, the probability of leaving unemployment to employment fell strongly. In particular, the probability of an unemployed worker to find a job in his previous sector of employment dropped dramatically from 46.1% to 30.3%. The probability of an unemployed worker to find a job in another sector also fell, but by less (from

34.4% to 28.2%). Finally, the exits from non-participation did not change significantly between the two decades.

We now look at the different time series in detail. The evolution of the joint probability of experiencing a sectoral change together with a job-to-job transition is in Figure A.16 in the appendix. The left panel displays these probabilities for different age groups of male workers, while the right panel shows the same for female workers. While there is no long-term trend in the data, the series are strongly procyclical. Furthermore, the cylicality is falling with age. In order to keep the analysis tractable, in the remainder of this section, we only discuss the results for men aged between 25 and 55.[22]

Figure A.17 depicts different measures of flows between sectors, while Figure A.18 does the same for occupations (both figures are in the appendix). The left panel shows the fraction of new employment relationships which involve a worker who has changed sector, and who has made either a direct job-to-job transition, or who has been previously unemployed, or not in the data set. The right panel displays the fraction of new employment relationships which involve a worker who has changed occupation *conditional on* a certain labor market transition. The latter transition thus abstracts from movements in the number of labor market transitions, and focuses on the fraction of labor market transitions which lead to a change of sector in the total number of a certain labor market transition. As for trend behavior, none of the series features a strong long-run trend, with one exception: The conditional probabilities of changing sector and of changing occupation after an unemployment spell has been strongly rising since the early 1980s. Thus, the unemployed seem to have become occupationally more mobile during the last two decades. This might be an indication for Ljungqvist-Sargent type turbulence: If the skills of the unemployed started depreciating more quickly from the early 1980s, then it is likely that the unemployed will have a lower propensity to return to their sector and/or occupation in later periods.

[22]The results for all age groups, and men and women, are similar with respect to long-run trends and cyclicality. They are available from the authors upon request.

Gross Sectoral Flows and Outsourcing

Structural change does not only occur because workers are moving from one economic sector to another. Organizational changes within firms can also play an important role. In particular, firms might split up along their business divisions. As an example, a car manufacturer might create a subsidiary firm dealing uniquely with the logistics of the manufacturer. In the extreme case, the subsidiary firm will employ exactly those workers that were previously employed by the manufacturer, and perform exactly the same tasks. This case of "outsourcing" would show up as a sectoral employment shift, although the tasks performed in the economy have not changed. In order to test whether outsourcing is driving our results, we employ the following strategy:[23] Outsourcing as in the case described above would involve a sectoral transition of an individual worker, but not a change of occupation. We therefore analyze which percentage of sectoral transitions involve a change of occupation as well. As direct job-to-job transitions are likely to play the most important role in this respect, we concentrate on these flows. The result is in Table 4.5.

Table 4.5: Percentage of sectoral EE flows involving a change of occupation for different time periods

1976-2000	1976-80	1981-85	1985-90	1991-95	1996-2000
58.3	62.3	55.9	61.8	57.4	54.0

Source: IABS-R01 and authors' calculations.

It becomes apparent that in all time periods considered, the majority of direct job-to-job transitions across sectors go together with a change of occupation. Furthermore, the percentage of sectoral EE flows involving a change of occupation has not fallen dramatically, as would have been the case if outsourcing had been a major driving force behind structural change. We see these results as evidence that outsourcing could have played some

[23]If there was firm information in the data set we use, we could analyze this issue in greater detail. However, this is unfortunately not the case, i.e. we only dispose of information on individual workers.

role, but certainly not an overwhelming one.

4.5.2 Net Flows

Having examined gross flows and sectoral inflows and outflows, we now turn to the analysis of net sectoral flows, i.e. changes in sectoral employment stocks. We calculate two different measures of net reallocation: the first measure has a net effect on sectoral employment stocks on a monthly basis, the second has a net effect on a yearly basis. Note that these two measures can move independently from each other, depending on which proportion of short-run turbulence is canceled out over the year.

Both time series are in Table 4.6 and in the left panel of Figure 4.4. The results show a marked difference between the two time series computed. Net flows on an monthly basis display a relatively small, but clear downward trend. This implies that the short-run variation in net changes has declined over time. Calculating net flows from seasonally adjusted worker flows reveals that this decline is entirely due to seasonal factors. Net flows on a yearly basis, on the other hand, increased over the same time period, and especially in the early 1990s. Given the results obtained for the modified Lilien index in Section 4.4.2, the latter result is not surprising. However, the fact that at the same time seasonally-induced short-run variations declined is somewhat of a puzzle.

Accounting for Changes in Employment Stocks: The Role of Different Labor Market Transitions

Having found that the evolution of employment stocks changed significantly from the beginning of the 1990s, we now want to analyze in more detail where these changes come from. In order to do so, we calculate the flow components of changes in stocks. Note that sectoral reallocation can be expressed in terms of flows:

$$net_t/L_t = \left[\sum_{j=1}^{J} |EEI_{j,t} - EEX_{j,t} + UE_{j,t} - EU_{j,t} + NE_{j,t} - EN_{j,t}|\right] \cdot \frac{1}{L_t}$$

We calculate both the differences $EEI - EEX$, $NE - EN$, $UE - EU$, and the individual flows. We do this for the economy as a whole, and for two sectors, the one with the highest growth in employment share (business-related services), and the one with the strongest decline in its employment share (consumer goods).

Net Flows: Aggregate Results

The results for the economy as a whole are in Table 4.6. Several features are noteworthy. First, direct job-to-job transitions only play a minor role for structural adjustment. Not only is their level low relative to the other flows, but their net impact, measured by the difference between EEI and EEX, is low as well. Furthermore, their net effect over the time period considered is relatively stable. Second, both according to their level and their net effect, the flows between employment and unemployment are much more important. The level of these flows is relatively stable until the mid-1990s and increases thereafter. Finally third, the flows between employment and non-registration play the most important role. This is both true for the level of the gross flows, and for the net effect, which peaked in the second half of the 1990s.

The analysis in this section up to now was for the economy as a whole. However, given the divergence in the evolution of employment between sectors, one would presume that there are also important differences in the way these net changes come about. In order to investigate this matter further, we again look at the differences between flows analyzed above, as well as at individual flows. This time, however, we do so for two sectors: first, the consumption goods sector, which lost 35% of its employment share between

Table 4.6: Yearly net and gross flows across sectors as share of the social security workforce, and ratio of net to gross flows

	1981-2000	81-85	85-90	91-95	96-00
Gross flows	36.8	36.5	37.4	34.0	39.5
0.5*(EEI+EEX)	3.6	2.8	4.0	3.8	4.0
UE+EU	11.7	13.3	12.0	10.3	11.4
NE+EN	21.5	20.3	21.5	19.9	24.1
Net flows, yearly basis	2.0	1.8	2.1	2.3	1.9
$\lvert EEI - EEX \rvert$	0.4	0.4	0.5	0.5	0.4
$\lvert UE - EU \rvert$	1.3	1.7	0.8	1.3	1.3
$\lvert NE - EN \rvert$	1.8	1.4	2.3	1.4	1.9
Net flows, yearly basis, to gross flows	5.5	4.8	5.7	6.7	4.8
Net flows, monthly basis	10.6	11.1	11.1	9.7	10.6

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. All figures in per cent.

1975 and 2001, and second, the business-related service sector, whose employment share grew by 75% during the same period.

Net Flows: Growing vs. Shrinking Sectors

The results for the consumption goods sector are in Table A.13, and those for the business-related service sector are in Table A.14 in the appendix. Direct job-to-job transitions are higher in the growing sector. The net contribution of these transitions to employment change ($\lvert EEI - EEX \rvert$) is very small in both sectors though.

Two noteworthy aspects differentiate the two sectors. First, the outflow rates are not appreciably different, and the one for the growing sector is even higher (22.9% for the service sector and 20.7% for the consumption goods sector). Higher growth of the service sector can be attributed to its higher inflow rate (25.7%, vs. 18.7% in the consumption goods sector). Second, there is a large difference in the net contribution of the flows between employment and unemployment. For the shrinking sector, these flows are relatively high (53% of sectoral inflows), and they play by far the most important role for net sectoral employment changes. This is not the case for the business-related service sector: here, unemployment flows only play a minor role (19% of sectoral inflows). By contrast, the transitions between non-registration and employment are relatively low for the declining sector (29% of sectoral inflows), and are not important for its net employment changes. For the growing sector, the opposite is true: these transitions are high (62% of sectoral inflows), and they are by far the most important contributor to changes in the employment share. We conclude that direct job-to-job transitions only play a minor role for net worker reallocation in both sectors, flows between unemployment and employment are most important for this purpose in the shrinking sector, which is the case for transitions between non-registration and employment in the growing sector. The results featured by the consumption goods sector and the business-related services sector can be found for the other sectors of the economy as well, depending on their respective growth performance. In other words, the features of the consumption goods sector are shared by the other shrinking sectors in the economy, and those of the business-related services sector are shared by the other growing sectors.

Accounting for Changes in Net Flows: Sectoral Inflow and Outflow Rates

In the previous section, we analyzed which labor market transitions are most important for net changes in sectoral employment. Now, we want to examine which sectors were mainly responsible for the rise in the Lilien index documented above. In order to do so, we calculate inflow and outflow rates for the economy at the six- and sixteen-sector level. Inflow rates for sector j, I_j/E_j, are calculated as the number of workers employed in a sector who were not employed in the same sector one year before - i.e. they can have been employed in a different sector, unemployed, or not in the sample - divided by the employment stock of that sector. Conversely, outflow rates for sector j, X_j/E_j, are the number of workers leaving a sector, to employment in a different sector, to unemployment, or to out of the sample, divided by the employment stock. The results for six sectors are in Table A.15; Tables A.16 and A.17 contain the inflow and outflow rates for 16 sectors. The inflow rates into the different sectors behave very similarly: there is no discernible long-run trend, and the rates are procyclical. The same is true for the outflow rates, although the volatility of the outflows rates is generally lower, with the construction sector being an obvious exception.

In order to determine which sectors played the most important role for the increase in worker reallocation recorded above, we calculate the difference between worker inflows and outflows. This yields the change in the employment stock of a sector, which in turn can be used to calculate the change in sectoral employment shares. The results are in Table A.18. The second column shows that the construction sector, as well as services in general, have experienced the most important employment changes during the time period 1975-2001. In order to find out what caused the increase in the Lilien index in the 1990s, one has to look at the evolution over time of the net employment changes. It becomes apparent that not a single sector, or a single group of sectors, is to blame. In the first half of the 1990s, the production sectors, and the consumption goods sector, were subject to an important increase in turbulence, while the service sectors experienced a volatility of net employment changes which was below average (business- and household-related services) or at least not significantly above average (social services). In the second half of the 1990s, the situation was completely different; the production and consumption sectors displayed relatively stable net employment changes, while turbulence in the transport and communication sector, and in business-related and household-related services increased sharply. Thus, the increase in turbulence over the 1990s was not due to a single source over the whole decade. Rather, the impact of the production sector was felt more strongly during the first half, while the same was true for the service sector during the second half of the 1990s.

4.5.3 Worker Reallocation Over the Business Cycle

The effect of the business cycle on the economy as a whole and on the labor market in particular has been a contentious issue at least since the times of Schumpeter (1942). On the one hand, recessions can be seen as being "cleansing", because they are times when outdated techniques and products are squeezed out of the market (Caballero and Hammour, 1994). On the other hand, recessions coincide with sharp declines in job-to-job transitions, which generally improve the quality of worker-firm matches (Barlevy, 2002, Krause and Lubik, 2006a). Recessions can thus lead to a reduction in the average quality of newly created matches, i.e. they can have a "sullying" impact.

We add a new dimension to this debate by looking at the cyclicality of sectoral and occupational changes. The cylicality of gross flows and sectoral mobility and occupation mobility can be seen in Figures A.17 and A.18 respectively, which examine both transitions going together with a change of sector or occupation (left panel in the figures), and changes of sector or occupation conditional on a certain transition (right panel in the figures). The state of origin clearly matters. In a recession, fewer workers enter a new employment involving a different occupation directly from another job or from non-participation. Furthermore, given a transition from those two states of origin, the probability of changing sector or occupation goes down in a recession as well. Workers take advantage of favorable business cycle conditions in order to engage in on-the-job search, which then often results in a change of sector or occupation. On the contrary, in a recession, workers search less on-the-job, and even if they are successful in finding a new job, this transition is less likely to involve an occupational change than in a cyclical upswing.[24]

[24]The pro-cylicality of on-the-job search has been established by a number of researchers, including Burgess (1993) for the UK, and Fallick and Fleischman (2004) and Nagypál

The picture looks different for workers coming from unemployment. In a downturn, the number of workers making a transition from unemployment to employment and switching occupation *increases*. However, the probability of changing occupation conditional on having made a transition from unemployment to employment is falling. In other words, flows from unemployment to employment are generally going up in a recession.[25] This also raises the number of UE transitions which go together with a new occupation, but the share of UE transitions involving an occupational switch is falling. Therefore, in a recession, the probability of an unemployed worker finding a new job in the sector he was previously working in is going up. This is in all likelihood due to the fact that, in a recession, the proportion of workers who have only very recently joined the pool of the unemployed, is rising. These workers usually command more than average sector- or occupation-specific human capital and will be rehired quickly in their sector (occupation) of origin.

It is also instructive to analyze the behavior of net and gross sectoral mobility, depicted in Figure 4.4. In a recession, gross employment flows fall, which is mainly due to a reduction in the number of job-to-job transitions (cf. Bachmann, 2005). This is the "sullying" aspect of recessions. On the other hand, net flows go *up* in a downturn. This means that sectoral reallocation increases in bad times, i.e. recessions are then indeed times of economic restructuring, which could play a cleansing role. In an upswing, the labor market is relatively tight, leading workers to engage in on-the-job search. Direct job-to-job transitions are a consequence. However, workers are reluctant to change sector or occupation as this involves the loss of at least some sector- or occupation-specific human capital. Therefore, net employment changes are relatively low. In a downturn, the reverse is true: firms' hiring activity is low, and more workers have to change sector in order to find a job at all, even if this involves the loss of some specific human capital. In recessions, gross worker flows decline, even while net worker flows are

(2004) for the United States.

[25]The finding of procyclical exits from unemployment to employment is consistent with Burda and Wyplosz (1994).

increasing.

4.6 Conclusion

Like all industrial countries, Germany has experienced at least two decades of considerable structural change.[26] This paper set out to document the extent to which the labor market developments have mirrored the structural change in output composition. In particular, are gross and net labor market flows into and out of employment informative about the way structural change occurred? Was the decrease in employment in shrinking sectors a result of an increase in separations or a decrease in accessions? Was the increase in employment in growing sectors a result of an increase in accessions or a decrease in separations? Did the newly hired in growing sectors originate from outside the labor force, or were they unemployed, or even already employed? Have workers become more prone to switch occupational and industrial attachment? Are these processes sensitive to the business cycle? Has there been a recognizable change in recall behavior of firms, that is, to reemploy those with previous experience in the sector? In order to analyze the dynamics of structural change in more detail, we constructed worker flows from a panel data set covering 2% of the German social security workforce for the time period 1975-2001.

At the outset, we documented an important fact which, to our knowledge, has gone unnoticed in the literature: the pace of structural change in socially insured employment in the *west* German economy accelerated sharply after 1990, i.e. the manufacturing sector began shrinking more quickly, and the growth rate of the service sector increased significantly. While the employment share of the service sector rose by six percentage points in the period 1976-1990, that pace of change quickened to ten percentage points over the period 1991-2000. This development was accompanied by a significant in-

[26]For an international perspective, see van Riet et al. (2004), D'Agostino et al. (2006), and Marimon and Zilibotti (1998).

crease in "turbulence" or variance of net employment changes, as measured by the dispersion or variance of k-period growth rates.

A quarter century ago, Lilien (1982) argued that recessions were periods of accelerated structural change, and that the increase in unemployment theoretically could be the result of sharply diverging sectoral evolutions. Subsequent work by Abraham and Katz (1986) and others showed that this was not the case: sectoral movements in vacancies and unemployment tend to be highly correlated across sectors over the business cycle. In contrast to phenomena stressed by Lilien (1982), the changes we find in Germany appear to be of longer term nature.[27] Cyclical movements appear to mask low-frequency structural change which is more evident when differencing is performed on longer intervals. Interestingly, we found that gross worker (employment) flows and net worker flows - flows having a net impact on sectoral employment stocks - have not always moved together. In particular, net worker flows increased dramatically in the early 1990s, while gross worker flows only started to increase in a significant way after 1995. Put differently, the net sectoral "yield" from gross worker flows increased sharply since 1990.

We then investigated net worker flows in more detail. We found that job-to-job flows play only a minor role for net changes in sectoral employment, followed by transitions between employment and unemployment. Most important are flows between employment and non-participation (defined as being outside the group of employed or unemployed dependent-status employment). At the same time, net flows can vary significantly between sectors, as seen by a comparison of a sharply contracting sector (e.g. consumer goods) with a strongly growing sectors (e.g. business-related services). We showed that the employment share of the consumer goods sector fell mainly because of a low inflow rate, and not because of a high outflow rate. These results resemble the findings by Shimer (2005a) using aggregate time series

[27] It should be pointed out that, while we have also analyzed occupational changes, we have focused our attention on sectoral change because it is likely that the German system of apprenticeships and training introduces a considerable element of sector-specific human capital, and therefore immobility.

data. The opposite is true for the business-related services sector, however; its share in total employment increased due to a high inflow rate; the outflow rate out of employment was actually higher than in the consumer goods sector. We documented furthermore that, for the shrinking sector, both inflows and outflows were dominated by flows to and from the state of unemployment. By contrast, hirings from, and separations to non-participation were most important in the business services sector, which is similar to the findings by Fallick (1996), who examines hirings only.

Finally, while the data are available for a limited time period only, we investigated the behavior of net and gross flows over the business cycle. Net reallocation was found to be counter-cyclical, and gross reallocation to be pro-cyclical. We interpret this as an indication of both clogging and cleansing effects of recessions: job-to-job transitions involving a change of sector decline sharply in economic downturns; workers are forced to change sectors, which leads to rising net reallocations. The mechanisms by which structural change occurs shed light on the effects of active and passive labor market policies. In general, economies can achieve structural change either by forcing costly mid-career industrial and occupational changes, or by "attrition", i.e. parking displaced workers in long-term unemployment, early retirement or disability pension, using retirements and voluntary separations where possible to reduce workforces, while relying on labor force entrants as a source of new workers. Thus while we have refrained in this paper from modeling structural change explicitly, our findings have implications for the relevant class of models which can help understand structural change in Germany. Consistent with the recent contribution by Rogerson (2005), we find that German workers - especially older ones - who lose their jobs in shrinking sectors tend to leave the labor force after extended spells in unemployment. Growing sectors tend to recruit new employees from outside the socially insured labor force. We do not find a significant component of net employment growth originating in transitions through unemployment, as in Lucas and Prescott (1974).

The weight of the evidence presented in this paper supports the proposition that structural change accelerated in Germany around 1990. Our analysis is silent on causes, however. The structural break could be related to the significant appreciation of an undervalued real exchange rate, which resulted from higher inflation and the collapse of the European Monetary System in the early 1990s. At the same time, German unification unlocked new sources of production factors as well as new market opportunities, and will continue to spur both structural change as well as institutional reform. Eastern enlargement of the European Union represents much the same process, with much larger long-term impact, yet at a much lower pace. To understand better the root causes of the shifts we have identified, research will need to focus on more detailed data, i.e. geographically-based, matched firm-employee datasets.

Chapter 5

Conclusions and Outlook

Many European countries have been haunted by high and persistent levels of unemployment, at least since the 1980s. This has led to an ever growing interest in the dynamics of the labour market. The theoretical approach in this context has been largely dominated by the search and matching model of the labour market. The empirics of this "flow approach" to the labour market have dealt with the analysis of job and worker flows. The present thesis has made both theoretical and empirical contributions to the research on labour market dynamics. The first chapter gave an overview of the relevant literature, stressing both the theoretical foundations and the empirical approach and results. For the German labour market, I pointed out that there is a relative lack of empirical evidence on flow dynamics. Chapter 2 analysed the effects of endogenising the job destruction decision in a search and matching model with *ex ante* heterogeneity of firms and workers. Chapters 3 and 4 made empirical contributions to the analysis of worker flows on the German labour market. Chapter 3 was mainly concerned with the cyclical features of worker flows in general. In contrast to Chapter 2, the issue of match separations was analysed in a business-cycle context. Chapter 4 focused on how the labour market deals with structural change in the economy. In the following, I briefly discuss the main findings of the last three chapters, and conclude with an outlook on topics for future research in this area.

Chapter 2 analysed a search and matching model of the labour market with *ex ante* heterogeneity and endogenous job destruction. It combined the model of endogenous job destruction by Mortensen and Pissarides (1994) with the one by Marimon and Zilibotti (1999), which features *ex ante* heterogeneous firms and workers. The latter model takes into account the fact that unemployment subsidies have two effects: first, there is a *disincentive effect*, which implies that unemployed workers raise their reservation wage with rising unemployment benefits. Second, with *ex ante* heterogeneous firms and workers, unemployment benefits also act as a *search subsidy*. This means that unemployment benefits on average lead to both a higher quality and a higher duration of matches.[1] However, as the model by Marimon and Zilibotti (1999) features exogenous job destruction, it only takes into account the effect on match quality, and fails to generate higher match duration. I therefore augmented their model by endogenising the job destruction decision. This enables agents in the model to hold on to a match characterised by a high match quality (which is fixed during the lifetime of the match), even though the stochastic productivity component temporarily features a low realisation. I showed that endogenising the job destruction decision has far-reaching consequences for the other results generated by the model. In particular, this concerns the claim by Marimon and Zilibotti (1999) that an increase in the probability of firms and workers to encounter a "bad" match in the labour market, i.e. an increase of the mismatch parameter in the production function, can explain the increase in inequality in the United States and the rise in European unemployment rates since the 1980s. With *endogenous* job destruction, this result no longer holds, because of the mechanism described above, that is an increased stability of "good" matches. In my simulation exercise, a higher mismatch parameter leads to a *fall* in the unemployment rate. I therefore argue that the results by Marimon and Zilibotti (1999) rely on an *ad hoc* assumption, which is unlikely to hold in practice. In particular, it is not clear why job destruction should have been governed by

[1] For recent evidence in support of these effects, see Tatsiramos (2006).

a constant and exogenous process over the last three decades, even though labour markets have dramatically changed in terms of exogenous shocks, institutions, and outcomes. As a consequence, more research concerning the nature of job destruction seems to be called for.

Chapter 3 started out with an investigation of worker flows in the West German economy for the time period 1975-2001 using a 2% sample of dependent-status (social security) employment. Because of the relatively long time period covered, the accuracy of the data (the information comes from compulsory notifications which are exact to the day), and the large sample size, this data set is particularly well suited for this purpose. Nevertheless, it had not been used to give a complete picture of worker flows before. This chapter filled this gap by answering questions pertaining to the general workings of the labour market, such as which workers are most likely to change job, how important are different labour market transitions quantitatively, or which differences there are between age cohorts, and men and women, in terms of labour market mobility. One of the results was that direct job-to-job transitions play a very important role quantitatively, especially for the young, and for men. I then proceeded to analyse in detail the cyclical features of accessions, separations, and their underlying worker flows, and found that accessions vary much more than separations over the time period considered. Finally, I investigated the question of why workers become unemployed in a recession using a decomposition proposed by Nagypál (2004). The results showed that the conditional probability that a worker separates from his employer is flat for the time period 1975-2001, while the conditional probability of becoming unemployed upon separating and having stayed in the labour force is strongly countercyclical. Therefore, one important reason for increased flows into unemployment during a recession is the reduced hiring activity of firms during economic downturns. However a qualification to this result is called for. The flow composition of separations changes considerably over the business cycle: transitions from employment to unemployment are strongly countercyclical, while direct job-to-job transitions are strongly procyclical. Consequently, the flatness of separations should *not* be read as evidence that the job destruction process is constant over the business cycle. Calibrating search and matching models with a constant and exogenous job destruction process is therefore clearly not warranted in the light of the evidence presented in Chapter 3. Rather, a model with a countercyclical job destruction process and on-the-job search seems to be a much better description of the data.[2]

Chapter 4, which is joint work with Michael C. Burda, was concerned with an empirical investigation of the evolution of structural change and its impact on labour market dynamics in West Germany during the time period 1975-2001. The first, and striking, finding was that the pace of sectoral reallocation in *West* Germany accelerated markedly around 1990, and did not return to the lower levels of the 1980s afterwards. We then investigated how the labour market deals with structural change. We found that differences in growth rates between sectors are mainly due to differences in inflow rates, not outflows rates. This implies, for example, that sectors shrink because they hire less workers than growing sectors, not because more workers leave. In a way, this mirrors the results in Chapter 3, where hirings played a much more important role than separations for the cyclical features of labour market dynamics. Our investigation also showed that employment growth of expanding sectors tends to represent workers from outside the labour force, while declining sectors tend to release workers into unemployment. Direct job-to-job transitions, which were found to be crucial for the cyclical dynamics of the labour market in Chapter 3, do not play an important role for the sectoral reallocation of employment. Finally, our results suggested that the business cycle has a strong impact on the extent of sectoral reallocation in the economy. In particular, gross flows tend to decline in recessions, while net flows tend to rise. Recessions can thus be seen to involve both a clogging and a cleansing effect. We argued that our results are generally informative for macroeconomic modelling. In particular, our evidence is consistent with

[2] See Mortensen and Nágypal (2005) for a model incorporating these features.

Rogerson (2005) in that the adjustment of shrinking sectors often leads to prolonged spells of unemployment, or to exits from the labour force. On the other hand, we do not find a significant component of net employment growth originating in transitions through unemployment, as in Lucas and Prescott (1974). Furthermore, our results shed light on the way labour market policies shape the way structural change is managed. In Germany, this seems to occur mainly through the provision of generous unemployment subsidies for workers who are leaving a declining sector, and thereafter often exit from the labour force altogether.

While giving some answers, this dissertation has also opened up new directions for future research. Chapters 2 and 3 point to the importance both of the nature of job destruction, and of hirings.[3] As mentioned in Chapter 1, in the literature on job flows, Davis et al. (1996) established that job destruction is more cyclical than job creation, at least in manufacturing. The more recent work on worker flows, including Chapter 3 of this dissertation, leads to much more emphasis on the hiring margin. It would therefore be an important achievement to reconcile these facts in a quantitatively successful theoretical model that includes job-to-job transitions. Furthermore, given the results in Chapters 2 and 3, more empirical analyses at the firm level seem to be called for. As firms' decisions in this context do not only include hirings and firings, wage dynamics should be considered at the same time. As shown by Abowd et al. (2006), such an analysis should also take into account heterogeneity among firms, which seems to be at least as important as heterogeneity among workers. This, however, requires the use of linked employer-employee data.

While Chapter 4 analysed the extent of structural change and its effects on the West German labour market, it was silent on the causes of the increase in sectoral reallocation which occurred around 1990. Of particular interest are the roles played in this context by German reunification, the eastward enlargement of the European Union, and movements of the real exchange

[3] Note that the theoretical model in Chapter 2 does not distinguish between job and worker flows, and that Chapter 3 considers worker flows only.

rate. Another factor that we investigated is outsourcing. Given that we used a data set which contains information on worker histories only, this analysis was necessarily limited in scope. Again, the firm side should be considered as well, preferably using matched firm-employee data. As pointed out above, our results also have implications for labour market policies. It would therefore be interesting to analyse the implications of such policies in an international context. How do different countries deal with sectoral worker reallocation? What does this imply for the aggregate economy, the labour market, and individual workers? With ongoing, and in Germany accelerated, structural change, such questions are of great importance and should be addressed in future research.

In sum, I hope that the contributions made in this dissertation have not only enhanced our understanding of labour market dynamics, but that they have also opened up new and exciting directions of research.

Bibliography

Abowd, J. M., Corbel, P., and Kramarz, F. (1999). The entry and exit of workers and the growth of employment: An analysis of French establishments. *The Review of Economics and Statistics*, 81(2):170–187.

Abowd, J. M., Kramarz, F., and Roux, S. (2006). Wages, mobility, and firm performance: Advantages and insights from using matched worker-firm data. *Economic Journal*, 116:F245–F285.

Abraham, K. G. and Katz, L. F. (1986). Cyclical unemployment: Sectoral shifts or aggregate disturbances? *Journal of Political Economy*, 94(3):507–22.

Acemoglu, D. and Shimer, R. (1999). Efficient unemployment insurance. *Journal of Political Economy*, 107(5).

Addison, J. T. and Blackburn, M. L. (2000). The effects of unemployment insurance on postunemployment earnings. *Labour Economics*, 7:21–53.

Aghion, P., Howitt, P., and Violante, G. (2002). Technological progress, luck, and the variability of earnings. mimeo, University College, London.

Akerlof, G. A., Rose, A. K., and Yellen, J. L. (1988). Job switching and job satisfaction in the U.S. labor market. *Brookings Papers on Economic Activity*, 1988(2):495–594.

Albrecht, J. and Vroman, S. (2002). A matching model with endogenous skill requirements. *International Economic Review*, 43(1):283–305.

Anderson, P. and Meyer, B. (1994). The extent and consequences of job turnover. *Brookings Papers: Microeconomics*, pages 177–199.

Andolfatto, D. (1996). Business cycles and labor market search. *American Economic Review*, 86:112–132.

Atkinson, A. B. and Micklewright, J. (1991). Unemployment compensation and labor market transitions: A critial review. *Journal of Economic Literature*, 29(4):1679–1727.

Autor, D. H., Katz, L. F., and Kearney, M. S. (2005). Trends in U.S. wage inequality: Re-assessing the revisionists. NBER Working Paper 11627, National Bureau of Economic Research, Inc.

Bachmann, R. (2003). Worker flows in five OECD countries. Paper presented at the EMAR Workshop of the Department for Trade and Industry, London, UK.

Bachmann, R. (2005). Labour market dynamics in Germany: Hirings, separations, and job-to-job transitions over the business cycle. Collaborative Research Center 649 Discussion Paper 2005-45, Humboldt-Universität zu Berlin.

Balassa, B. (1964). The purchasing power parity doctrine: A reappraisal. *Journal of Political Economy*, 72(6):584–596.

Baltagi, B. (2005). *Econometric analysis of panel data*. Chichester, England: John Wiley & Sons.

Barlevy, G. (2002). The sullying effect of recessions. *Review of Economic Studies*, 69(1):65–96.

Bauer, T. K., Bender, S., and Bonin, H. (2007). Dismissal protection and worker flows in small establishments. *Economica*. forthcoming.

Baumol, W. J. (1967). Macroeconomics of unbalanced growth: The anatomy of urban crisis. *American Economic Review*, 57(3):415–26.

Bean, C. (1994). European unemployment; a survey. *Journal of Economic Literature*, 32:573–619.

Bean, C., Layard, R., and Nickell, S. (1986). The rise in unemployment: A multi-country study. *Economica*, 53:S1–S22.

Bender, S., Haas, A., and Klose, C. (1999a). Die IAB-Beschäftigtenstichprobe 1975-1995. *ZA-Information*, 45:104–115.

Bender, S., Haas, A., and Klose, C. (1999b). Mobilität allein kann Arbeitsmarktprobleme nicht lösen. *IAB kurzbericht*, 2.

Bender, S., Haas, A., and Klose, C. (2000). Iab employment subsample 1975-1995. opportunities for analysis provided by the anonymised subsample. IZA Discussion Paper 117, Institute for the Study of Labor (IZA).

Bender, S. and von Wachter, T. (2006). In the right place at the wrong time - the role of firms and luck in young workers' careers. *American Economic Review*, 96(5):1679–1705.

Bentolila, S. and Jimeno, J. F. (2006). Spanish unemployment: The end of the wild ride? In Werding, M., editor, *Structural unemployment in Western Europe: Reasons and remedies, CESifo Seminar Series*. Cambridge, Massachusetts: The MIT Press.

Binmore, K., Rubinstein, A., and Wolinsky, A. (1986). The Nash bargaining solution in economic modelling. *Rand Journal of Economics*, 17:176–188.

Blanchard, O. (2006). European unemployment: The evolution of facts and ideas. *Economic Policy*, 21(45):5–59.

Blanchard, O. and Diamond, P. (1992). The flow approach to labor markets. *American Economic Review Papers and Proceedings*, 82(2):354–359.

Blanchard, O. and Diamond, P. A. (1989). The Beveridge Curve. *Brookings Papers on Economic Activity*, 1989(1):1–76.

Blanchard, O. and Diamond, P. A. (1990). The cyclical behaviour of gross flows of workers in the US. *Brookings Papers on Economic Activity*, 2:85–11.

Blanchard, O. and Jimeno, J. (1995). Structural unemployment: Spain versus Portugal. *American Economic Review Papers and Proceedings*, 85(2):212–218.

Blanchard, O. and Landier, A. (2002). The perverse effect of partial labour market reform: Fixed-term contracts in France. *The Economic Journal*, 112:F214–F244.

Blanchard, O. and Portugal, P. (2001). What hides behind an unemployment rate: Comparing Portuguese and U.S. labor markets. *American Economic Review*, 91(1):187–207.

Blanchard, O. and Summers, L. (1986). Hysteresis and the European unemployment problem. *Cambridge, MA: NBER Macroeconomics Annual*, pages 15–78.

Blanchard, O. and Wolfers, J. (2000). The role of shocks and institutions in the rise of European unemployment: The aggregate evidence. *The Economic Journal*, 110:C1–33.

Boeri, T. (1999). Enforcement of employment security regulations, on-the-job search and unemployment duration. *European Economic Review*, 43:65–89.

Bruno, M. and Sachs, J. (1985). *Economics of worldwide stagflation*. Cambridge, Massachusetts: Harvard University Press.

Burda, M. C. (1988). 'Wait unemployment' in Europe. *Economic Policy*, 7:391–425.

Burda, M. C. (1992). A note on firing costs and severance benefits in equilibrium unemployment. *Scandinavian Journal of Economics*, 39:479–89.

Burda, M. C. and Hunt, J. (2001). From reunification to economic integration: Productivity and the labor market in East Germany. *Brookings Papers on Economic Activity*, 2001(2):1–71.

Burda, M. C. and Mertens, A. (2001). Estimating wage losses of displaced workers in Germany. *Labour Economics*, 8(1):15–41.

Burda, M. C. and Wyplosz, C. (1994). Gross worker and job flows in Europe. *European Economic Review*, 38(6):1287–1315.

Burdett, K. (1978). A theory of employee job search and quit rates. *American Economic Review*, 68:212–220.

Burdett, K. (1979). Unemployment insurance payments as a search subsidy: a theoretical analysis. *Economic Inquiry*, 42:333–343.

Burgess, S. M. (1993). A model of competition between unemployed and employed job searchers: An application to the unemployment outflow rate in Britain. *Economic Journal*, 103(420):1190–1204.

Caballero, R. J. and Hammour, M. L. (1994). The cleansing effect of recessions. *American Econonomic Review*, 84(5):1350–1368.

Cahuc, P. and Zylberberg, A. (2004). *Labor economics*. Cambridge, Massachusetts: The MIT Press.

Cameron, A. and Trivedi, P. K. (2005). *Microeconometrics*. Cambridge: Cambridge University Press.

Campbell, J. Y. (1994). Inspecting the mechanism: An analytical approach to the stochastic growth model. *Journal of Monetary Economics*, 33(3):463–506.

Candelon, B. and Lütkepohl, H. (2001). On the reliability of Chow-type tests for parameter constancy in multivariate dynamic models. *Economics Letters*, 73(2):155–160.

Card, D. and Lemieux, T. (2001). Can falling supply explain the rising return to college for younger men? a cohort-based analysis. *Quarterly Journal of Economics*, 116(2):705–746.

Centeno, M. and Novo, A. A. (2006). The impact of unemployment insurance generosity on match quality distribution. *Economics Letters*, 93(2):235–241.

Chamberlain, G. (1980). Analysis of covariance with qualitative data. *Review of Economic Studies*, 47(1):225–38.

Chung, K. (2001). *A course in probability theory*. London: Academic Press.

Clark, C. (1940). *The conditions of economic progress*. London: Macmillan.

Cole, H. and Rogerson, R. (1999). Can the Mortensen-Pissarides matching model match the business cycle facts? *International Economic Review*, 40(4):933–959.

Comin, D. and Phillipon, T. (2005). The rise in firm-level volatility: Causes and consequences. In Gertler, M. and Rogoff, K., editors, *NBER Macroeconomics Annual*, volume 20, pages 167–202. MIT Press.

D'Agostino, A., Serafini, R., and Ward-Warmedinger, M. (2006). Sectoral explanations of employment in Europe - the role of services. ECB Working Paper Series 625, European Central Bank.

Davis, S. J., Faberman, R. J., and Haltiwanger, J. (2006). The flow approach to labor markets: New data sources, micro-macro links and the recent downturn. *Journal of Economic Perspectives*, 20(3):3–26.

Davis, S. J. and Haltiwanger, J. (1999). Gross job flows. In Taylor and Woodford (1999), chapter 41, pages 2711–2805.

Davis, S. J., Haltiwanger, J., and Schuh, S. (1996). *Job creation and destruction*. Cambridge, Massachusetts: The MIT Press.

Den Haan, W., Haefke, C., and Ramey, G. (2001). Shocks and institutions in a job matching model. NBER Working Paper 8463, National Bureau of Economic Research.

Di Tella, R. and MacCulloch, R. (2005). The consequences of labor market flexibility: Panel evidence based on survey data. *European Economic Review*, 49(5):1225–59.

Diamond, P. (1981). Mobility costs, frictional unemployment, and efficiency. *Journal of Political Economy*, 89(4):798–812.

Diamond, P. (1982a). Aggregate demand management in search equilibrium. *Journal of Political Economy*, 90(5):881–894.

Diamond, P. (1982b). Wage determination and efficiency in search equilibrium. *Review of Economic Studies*, 49(2):217–228.

Dolado, J., Kramarz, F., Machin, S., Manning, A., Margolis, D., and Teulings, C. (1996). The economic impact of minimum wages in europe. *Economic Policy*, pages 319–372.

Drèze, J. H. and Bean, C. R., editors (1990). *Europe's unemployment problem.* Cambridge, Massachusetts: The MIT Press.

Ebbinghaus, B. and Eichhorst, W. (2006). Employment regulation and labor market policy in Germany, 1991-2005. IZA Discussion Paper 2505, Institute for the Study of Labor (IZA).

Eckstein, Z. and van den Berg, G. J. (2006). Empirical labor search: A survey. *Journal of Econometrics*, 136(2):531–564.

Ehrenberg, R. G. and Oaxaca, R. L. (1976). Unemployment insurance, duration of unemployment and subsequent wage gain. *American Economic Review*, 84:754–776.

Erlinghagen, M. (2005). Entlassungen und Beschäftigungssicherheit im Zeitverlauf - Zur Entwicklung unfreiwilliger Arbeitsmarktmobilität in Deutschland . *Zeitschrift für Soziologie*, 34(2):147–168.

Fahr, R. and Sunde, U. (2004). Disaggregate matching functions. *Oxford Economic Papers*, 56(3):407–436.

Fahr, R. and Sunde, U. (2006a). Did the Hartz reforms speed up job creation? A macro-evaluation using empirical matching functions. IZA Discussion Paper 2470, Institute for the Study of Labor (IZA).

Fahr, R. and Sunde, U. (2006b). Regional dependencies in job creation: An efficiency analysis for Western Germany. *Applied Economics*, 38(10):1193–1206.

Fallick, B. (1996). The hiring of new labor by expanding industries. *Labour Economics*, 3(1):25–42.

Fallick, B. and Fleischman, C. A. (2004). Employer-to-employer flows in the U.S. labor market: the complete picture of gross worker flows. Finance and Economics Discussion Series 2004-34, Board of Governors of the Federal Reserve System (U.S.).

Farber, H. S. (1999). Mobility and stability: The dynamics of job change in labor markets. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics*, volume 3, pages 2439–2483. Amsterdam: Elsevier.

Fisher, A. G. (1935). *The clash of progress and security.* London: Macmillan.

Fitzenberger, B. and Garloff, A. (2005a). Descriptive evidence on labor market transitions and the wage structure in Germany. ZEW Discussion Paper 05-95, Zentrum für Europäische Wirtschaftsforschung.

Fitzenberger, B. and Garloff, A. (2005b). Unemployment, labor market transitions, and residual wage dispersion. ZEW Discussion Paper 05-04, Zentrum für Europäische Wirtschaftsforschung.

Fitzenberger, B. and Kohn, K. (2006). Skill wage premia, employment, and cohort effects: Are workers in Germany all of the same type? IZA Discussion Paper 2185, Institute for the Study of Labor (IZA).

Fitzenberger, B. and Kunze, A. (2005). Vocational training and gender: Wages and occupational mobility among young workers. *Oxford Review of Economic Policy*, 21(3):392–415.

Fitzenberger, B. and Spitz-Oener, A. (1999). Die Anatomie des Berufswechsels - Eine empirische Bestandsaufnahme auf Basis der BIBB/IAB-Daten 1998/1999. In Franz, W., Ramser, H. J., and Stadler, M., editors, *Bildung, Wirtschaftwissenschaftliches Seminar in Ottobeuren*, volume 33. Tübingen: Mohr Siebeck.

Fitzenberger, B. and Wilke, R. (2004a). New insights on unemployment duration and post unemployment earnings in Germany: Censored Box-Quantile regression at work. ZEW Discussion Paper 07-007, Zentrum für Europäische Wirtschaftsforschung.

Fitzenberger, B. and Wilke, R. (2004b). Unemployment durations in west-germany before and after the reform of the unemployment compensation system during the 1980s. ZEW Discussion Paper 04-24, Zentrum für Europäische Wirtschaftsforschung.

Fourastié, J. (1949). *Le grand espoir du XXe siècle; progrès technique, progrès économique, progrès social*. Paris: Presses universitaires de France.

Franz, W. (2006). *Arbeitsmarktökonomik*. Berlin: Springer. 6th edition.

Fredriksson, P. and Holmlund, B. (2006). Improving incentives in unemployment insurance: A review of recent research. *Journal of Economic Surveys*, 20(3):357–386.

Freeman, R. (2005). Labour market institutions without blinders: The debate over flexibility and labour market performance. NBER Working Paper 11286, National Bureau of Economic Research.

Friedman, M. (1968). The role of monetary policy. *American Economic Review*, 58:1–17.

Fuchs, V. R. (1980). Economic growth and the rise of service employment. NBER Working Paper 486, National Bureau of Economic Research.

Gathmann, C. and Schoenberg, U. (2006). How general is specific human capital? using mobility patterns to analyse skill transferability in the labour market. IZA Discussion Paper 2485, Institute for the Study of Labor (IZA).

Gottschalk, T. and Smeeding, T. (1997). Cross-national comparisons of earnings and income inequality. *Journal of Economic Literature*, XXXV:633–687.

Greenaway, D., Upward, R., and Wright, P. (2000). Sectoral transformation and labour-market flows. *Oxford Review of Economic Policy*, 16(3):57–75.

Groshen, E. L. and Potter, S. (2003). Has structural change contributed to a jobless recovery? Current Issues in Economics and Finance 8, Federal Reserve Bank of New York.

Haefke, C. (1999). The European unemployment puzzle: The importance of bargaining and endogenous job destruction in a dynamic matching model. mimeo, Pompeu Fabra University.

Hagedorn, M. and Manovskii, I. (2005). The cyclical behavior of equilibrium unemployment and vacancies revisited. 2005 Meeting Papers 460, Society for Economic Dynamics.

Hall, R. E. (1999). Labor-market frictions and employment fluctuations. In Taylor and Woodford (1999), chapter 17, pages 1137–1170.

Hall, R. E. (2005a). Employment efficiency and sticky wages: Evidence from flows in the labour market. *Review of Economics and Statistics*, 87(3):397–407.

Hall, R. E. (2005b). Job loss, job finding, and unemployment in the U.S. economy over the past fifty years. In Gertler, M. and Rogoff, K., editors, *NBER Macroeconomics Annual*. Cambridge, MA: The MIT Press.

Hall, R. E. and Milgrom, P. (2005). The limited influence of unemployment on the wage bargain. NBER Working Paper 11245, National Bureau of Economic Research.

Hamermesh, D. S. (1989). What do we know about worker displacement in the United States? *Industrial Relations*, 28(1):51–9.

Hunt, J. (1999). Has work-sharing worked in Germany? *Quarterly Journal of Economics*, 114(1):117–148.

Hunt, J. (2007). The economics of German reunification. In Durlauf, S. N. and Blume, L. E., editors, *New Palgrave Dictionary of Economics*. Palgrave MacMillan. forthcoming.

Isaoglu, A. (2006). Occupational mobility in Germany. mimeo, European University Institute.

Jovanovic, B. (1979). Job matching and the theory of turnover. *Journal of Political Economy*, 69:972–990.

Jovanovic, B. (1984). Matching, turnover, and unemployment. *Journal of Political Economy*, 92(1):108–22.

Jovanovic, B. and Moffitt, R. (1990). An estimate of a sectoral model of labor mobility. *Journal of Political Economy*, 98(4):827–52.

Kambourov, G. and Manovskii, I. (2004). Occupational mobility and wage inequality. IZA Discussion Paper 1189, Institute for the Study of Labor (IZA).

Katz, L. F. and Murphy, K. M. (1992). Changes in relative wages, 1963-1987: Supply and demand factors. *Quarterly Journal of Economics*, 107(1):35–78.

Kiefer, N. M. (1988). Economic duration data and hazard functions. *Journal of Economic Literature*, 26(2):646–79.

Kiyotaki, N. and Wright, R. (1993). A search-theoretic approach to monetary economics. *American Economic Review*, 83(1):63–77.

Krause, M. U. and Lubik, T. A. (2006a). The cyclical upgrading of labor and on-the-job search. *Labour Economics*, 13(4):459–477.

Krause, M. U. and Lubik, T. A. (2006b). On-the-job search and the cyclical dynamics of the labor market. Computing in Economics and Finance 2006 455, Society for Computational Economics.

Kuhn, P. J., editor (2002). *Losing work, moving on: International perspectives on worker displacement.* W. E. Upjohn Institute, Kalamazoo, Michigan.

Kydland, F. and Prescott, E. C. (1982). Time to build and aggregate fluctuations. *Econometrica*, 5:1345–1370.

Layard, R., Nickell, S., and Jackman, R. (2005). *Unemployment. Macroeconomic performance and the labour market.* Oxford, UK: Oxford University Press. Second edition.

Lazear, E. P. (1990). Job security provisions and employment. *Quarterly Journal of Economics*, 105(3):699–726.

Lee, D. and Wolpin, K. I. (2006). Intersectoral labor mobility and the growth of the service sector. *Econometrica*, 74(1):1–46.

Lemieux, T. (2006). Increasing residual wage inequality: Composition effects, noisy data, or rising demand for skill? *American Economic Review*, 96(3):461–498.

Lilien, D. M. (1982). Sectoral shifts and sectoral unemployment. *Journal of Political Economy*, 90(4):777–93.

Lindbeck, A. and Snower, D. J. (1986). Wage setting, unemployment, and insider-outsider relations. *American Economic Review*, 76(2):235–39.

Lindbeck, A. and Snower, D. J. (2001). Insiders versus outsiders. *Journal of Economic Perspectives*, 15:165–188.

Ljungqvist, L. (2002). How do lay–off costs affect employment? *The Economic Journal*, 112(482):829–853.

Ljungqvist, L. and Sargent, T. J. (1998). The European unemployment dilemma. *Journal of Political Economy*, 106(3):514–550.

Ljungqvist, L. and Sargent, T. J. (2003). European unemployment: From a worker's perspective. In Aghion, P., Frydman, R., Stiglitz, J., and Woodford, M., editors, *Knowledge, information, and expectations, in modern macroeconomics in honor of Edmund S. Phelps*. Princeton: Princeton University Press.

Ljungqvist, L. and Sargent, T. J. (2004). European unemployment and turbulence revisited in a matching model. *Journal of the European Economic Association*, 2(2-3):456–468.

Lucas, R. E. and Prescott, E. C. (1974). Equilibrium search and unemployment. *Journal of Economic Theory*, 7(2):188–209.

Lütkepohl, H. and Krätzig, M., editors (2004). *Applied time series econometrics*. Cambridge University Press, Cambridge.

Machin, S. and Manning, A. (1999). The causes and consequences of longterm unemployment in Europe. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics*, volume 3C. Amsterdam: Elsevier.

Maddison, A. (1987). Growth and slowdown in advanced capitalist economies. *Journal of Economic Literature*, 23(2):649–98.

Marimon, R. and Zilibotti, F. (1998). 'Actual' versus 'virtual' employment in Europe. Is Spain different? *European Economic Review*, 42(1):123–153.

Marimon, R. and Zilibotti, F. (1999). Unemployment vs. mismatch of talents: Reconsidering unemployment benefits. *Economic Journal*, 109(455):266–291.

Mavromaras, K. G. and Rudolph, H. (1995). "Recalls" - Wiederbeschäftigung im alten Betrieb. *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung*, 2.

Mavromaras, K. G. and Rudolph, H. (1998). Temporary separations and firm size in the German labour market. *Oxford Bulletin of Economics and Statistics*, 60(2):215–225.

McCall, J. J. (1970). Economics of information and job search. *Quarterly Journal of Economics*, 84(1):113–26.

Merz, M. (1995). Search in the labor market and the real business cycle. *Journal of Monetary Economics*, 36:269–300.

Merz, M. (2002). Search theory rediscovered: Recent developments in the macroeconomics of the labor market. In Davidson, C. and Woodbury, S. A., editors, *Search theory and unemployment*, pages 17–44. Kluwer Academic Publishers.

Meyer, B. (1990). Unemployment insurance and unemployment spells. *Econometrica*, 58:757–782.

Mönch, E. and Uhlig, H. (2005). Towards a monthly business cycle chronology for the Euro area. *Journal of Business Cycle Measurement and Analysis*, 2(1):43–69.

Mortensen, D. T. (1970). A theory of wage and employment dynamics. In et al., E. S. P., editor, *Microeconomic foundations of employment and inflation theory*, pages 124–66. New York: W.W. Norton.

Mortensen, D. T. (1982). The matching process as a noncooperative bargaining game. In McCall, J. J., editor, *The economics of information*, pages 233–254. Chicago: University of Chicago Press.

Mortensen, D. T. (1986). Job search and labor market analysis. In McCall, J. J., editor, *Handbook of labor economics*, pages 233–54. Chicago: University of Chicago Press.

Mortensen, D. T. (1988). Matching: Finding a partner for life or otherwise. *American Journal of Sociology*, 94(Supplement):S215–40.

Mortensen, D. T. (1994). The cyclical behavior of job and worker flows. *Journal of Economic Dynamics and Control*, pages 1121–42.

Mortensen, D. T. (2003). *Wage dispersion. Why are similar workers paid differently?* Cambridge, Massachusetts: The MIT Press.

Mortensen, D. T. and Nágypal, E. (2005). More on unemployment and vacancy fluctuations. IZA Discussion Paper 1765, Institute for the Study of Labor (IZA).

Mortensen, D. T. and Pissarides, C. A. (1994). Job creation and job destruction in the theory of unemployment. *Review of Economic Studies*, 61(3):397–415.

Mortensen, D. T. and Pissarides, C. A. (1999a). Job reallocation, employment fluctuations and unemployment. In Taylor, J. B. and Woodford, M., editors, *Handbook of Macroeconomics*, volume 1, chapter 18, pages 1171–1228. Amsterdam: Elsevier.

Mortensen, D. T. and Pissarides, C. A. (1999b). New developments in models of search in the labor market. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics*, volume 3, chapter 39, pages 2567–2627. Elsevier.

Mortensen, D. T. and Pissarides, C. A. (1999c). Unemployment responses to 'skill-biased' technology shocks: The role of labour market policy. *The Economic Journal*, 109:242–265.

Nagypál, E. (2004). Worker reallocation over the business cycle: The importance of job-to-job transitions. mimeo, Northwestern University.

Nagypál, E. (2005). Amplification of labor market fluctuations: Why vacancies don't like to hire the unemployed? 2005 Meeting Paper 206, Society for Economic Dynamics.

Nash, J. (1950). The bargaining problem. *Econometrica*, 18:155–162.

Neal, D. (1999). The complexity of job mobility among young men. *Journal of Labor Economics*, 17(2):237–61.

Ngai, L. R. and Pissarides, C. A. (2005). Structural change in a multi-sector model of growth. IZA Discussion Paper 1800, Institute for the Study of Labor (IZA).

Nickell, S. (1997). Unemployment and labor market rigidities: Europe versus North America. *Journal of Economic Perspectives*, 11(3):55–74.

Nickell, S., Nunziata, L., and Ochel, W. (2005). Unemployment in the OECD since the 1960s. What do we know? *The Economic Journal*, 115(500):1–27.

Nickell, S., Nunziata, L., Ochel, W., and Quintini, G. (2003). The Beveridge Curve, unemployment and wages in the OECD. In Aghion, P., Frydman, R., Stiglitz, J., and Woodford, M., editors, *Knowledge, information and expectations in modern macroeconomics: in honor of Edmund S. Phelps.* Princeton University Press.

OECD (1994). *Jobs study: Evidence and explanations.* Paris: OECD.

Padoa Schioppa, F. (1991). *Mismatch and labour mobility.* Cambridge: Cambridge University Press.

Petrongolo, B. and Pissarides, C. (2001). Looking into the black box: A survey of the matching function. *Journal of Economic Literature*, 39:390–431.

Phelps, E. S. (1968). Money-wage dynamics and labor-market equilibrium. *Journal of Political Economy*, 76:679–711.

Phelps, E. S. (1994). *Structural slumps.* Cambridge, Massachusetts: Harvard University Press.

Pissarides, C. A. (1979). Job matching with state employment agencies and random search. *Economic Journal*, 89:818–33.

Pissarides, C. A. (1984). Efficient job rejection. *Economic Journal*, 94:97–108.

Pissarides, C. A. (1985). Short-run equilibrium dynamics of unemployment, vacancies and real wages. *American Economic Review*, 75(4):676–90.

Pissarides, C. A. (1986). Unemployment and vacancies in Britain. *Economic Policy*, 3:499–559.

Pissarides, C. A. (1994). Search unemployment with on-the-job search. *Review of Economic Studies*, 61(3):457–75.

Pissarides, C. A. (1998). The impact of employment tax cuts on unemployment and wages: The role of unemployment benefits and tax structure. *European Economic Review*, 42:155–83.

Pissarides, C. A. (2000). *Equilibrium unemployment theory.* Cambridge, Massachusetts: The MIT Press.

Pissarides, C. A. (2006). Unemployment in Britain: A European success story. In Werding, M., editor, *Structural unemployment in Western Europe: Reasons and remedies, CESifo Seminar Series*. Cambridge, Massachusetts: The MIT Press.

Ramey, G. and Watson, J. (1997). Contractual fragility, job destruction and business cycles. *Quarterly Journal of Economics*, 112(3):873–911.

Rocheteau, G. (1999). Balanced-budget rules and indeterminacy of the equilibrium unemployment rate. *Oxford Economic Papers*, 51:399–409.

Rogerson, R. (1987). An equilibrium model of sectoral reallocation. *Journal of Political Economy*, 95(4):824–34.

Rogerson, R. (2005). Sectoral shocks, specific human capital and displaced workers. *Review of Economic Dynamics*, 8(1):89–105.

Rogerson, R., Shimer, R., and Wright, R. (2005). Search-theoretic models of the labor market: A survey. *Journal of Economic Literature*, 43(4):959–988.

Schettkat, R., editor (1996). *The flow analysis of labour markets*. London: Routledge.

Schmidt, C. M. (2000a). Persistence and the German unemployment problem: Empirical evidences on German labor market flows. *Economie et Statistique*, 332-333(2000-2/3):83–95.

Schmidt, C. M. (2000b). The heterogeneity and cyclical sensitivity of unemployment: An exploration of German labor market flows. *Ifo-Studien*, 46:73–98.

Schumpeter, J. (1942). *Capitalism, socialism and democracy*. New York: Harper & Row.

Shimer, R. (2005a). The cyclical behavior of equilibrium unemployment and vacancies. *American Economic Review*, 95(1):25–49.

Shimer, R. (2005b). The cyclicality of hires, separations, and job-to-job transitions. *Federal Reserve Bank of St. Louis Review*, 87(4):493–508.

Shimer, R. (2005c). Reassessing the ins and outs of unemployment. mimeo, University of Chicago.

Shimer, R. (2006). On-the-job search and strategic bargaining. *European Economic Review*, 50:811–830.

Slutsky, E. (1927). The summation of random causes as the source of cyclic processes. *Econometrica*, 5:105–146.

Statistische Ämter der Länder (2006). *Volkswirtschaftliche Gesamtrechnungen der Länder: Bruttoinlandsprodukt, Bruttowertschöpfung in den Ländern und Ost-West-Großraumregionen Deutschlands 1991 bis 2005* . Stuttgart: Statistisches Landesamt Baden-Württemberg.

Steiner, V. (2001). Unemployment persistence in the West German labour market: Duration dependence or sorting? *Oxford Bulletin of Economics and Statistics*, 2001/1:91–113.

Stigler, G. (1962). Information in the labor market. *Journal of Political Economy*, 70:94–104.

Stokey, N., Lucas, R. J., and Prescott, E. (1989). *Recursive methods in economic dynamics*. Cambridge, Massachusetts: Harvard University Press.

Tatsiramos, K. (2006). Unemployment insurance in Europe: Unemployment duration and subsequent employment stability. IZA Discussion Paper 2280, Institute for the Study of Labor (IZA).

Taylor, J. and Woodford, M., editors (1999). *Handbook of Macroeconomics, Volume 1B*. North-Holland, Amsterdam.

van Riet, A., Ernst, E., Madaschi, C., Orlandi, F., Rivera, A. S., and Benoît, R. (2004). Sectoral specialisation in the EU - A macroeconomic perspective. Occasional Paper Series 19, European Central Bank.

Vella, F. and Moscarini, G. (2004). Aggregate worker reallocation and occupational mobility in the United States: 1976-2000. 2004 Meeting Paper 183, Society for Economic Dynamics.

Velling, J. and Bender, S. (1994). Berufliche Mobilität zur Anpassung struktureller Diskrepanzen am Arbeitsmarkt. *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung*, 3.

Winkelmann, R. and Zimmermann, K. F. (1998). Is job stability declining in Germany? Evidence from count data models. *Applied Economics*, 30(11):1413–20.

Wooldridge, J. (2002). *Econometric analysis of cross section and panel data*. Cambridge, Massachusetts: The MIT Press.

Wunsch, C. (2005). Labour market policy in Germany: Institutions, instruments and reforms since unification. Discussion Paper 2005-06, University of St.Gallen.

Appendix A

Technical Appendices

A.1 Appendix to Chapter 1

Table A.1: Data sources

France	Bulletin Mensuel des Statistiques du Travail, various issues
Germany	Amtliche Nachrichten der Bundesagentur für Arbeit, Eckwerte der Arbeitsmarktstatistik, various issues; Statistik Hessen
Great Britain	National Statistics website (www.nomisweb.co.uk), OECD Economic Outlook 79 Database
Spain	Boletín Mensual de Estadística; OECD Economic Outlook 79 Database
US	Bureau of Labor Statistics website (www.bls.gov)

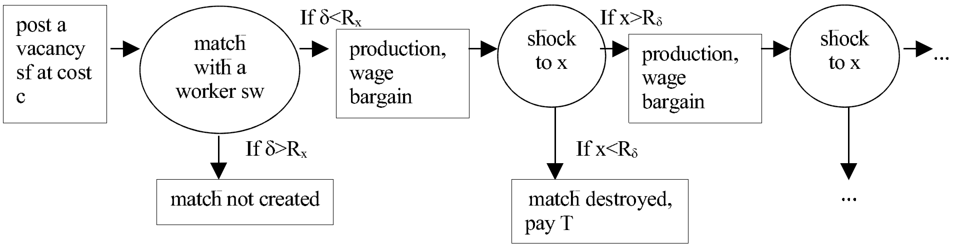
A.2 Appendix to Chapter 2

A.2.1 Parameters and variables

a	Importance of skill mismatch in the production function
b	Unemployment benefits
c	Cost of posting a vacancy
e	Employment
F	Distribution function of x
G	Distribution function of δ
G_1	Distribution function of sw
G_2	Distribution function of sf
R_δ	Inside reservation value of x for a given value of δ
R_δ^o	Outside reservation value of x for a given value of δ
R_x	Inside reservation value of δ for a given value of x
R_x^o	Outside reservation value of δ for a given value of x
sf	Workers' skills
sw	Firms' skill requirements
x	Idiosyncratic component of productivity
T	Firing cost
u	Unemployment
v	Vacancies
β	Workers' bargaining power
δ	Mismatch ($\lvert sf - sw \rvert$)
λ	Arrival rate of shocks to x
φ	Match productivity
ρ	Replacement rate
τ	Tax rate on wages
θ	Market tightness

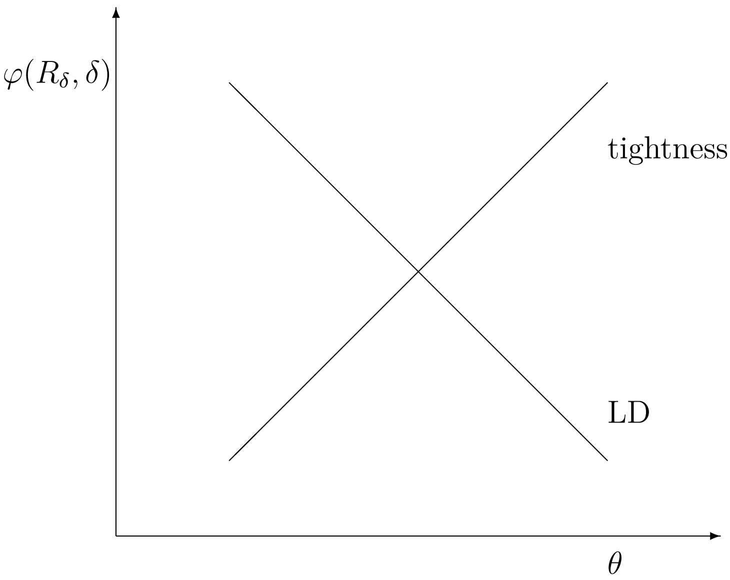
A.2.2 Figures

Figure A.1: Lifetime of a firm



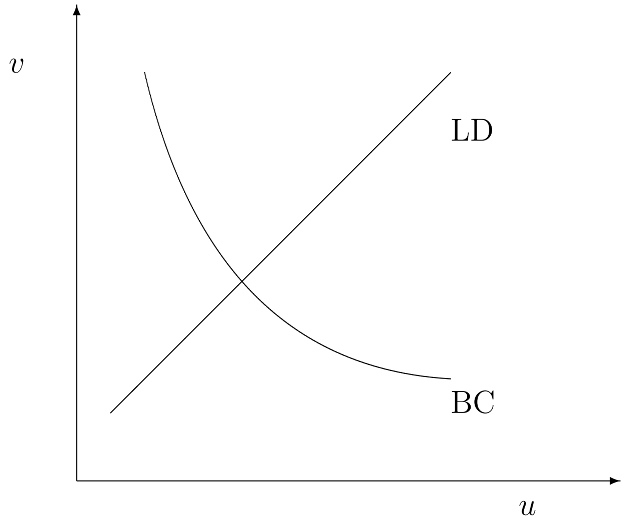
Notes: sf and sw are the firm and worker type, respectively. c and T are the vacancy and firing cost, respectively. x is idiosyncratic productivity, δ the degree of mismatch. R_x and R_δ are the reservation productivities given x and δ, respectively.

Figure A.2: Determination of reservation productivity and tightness



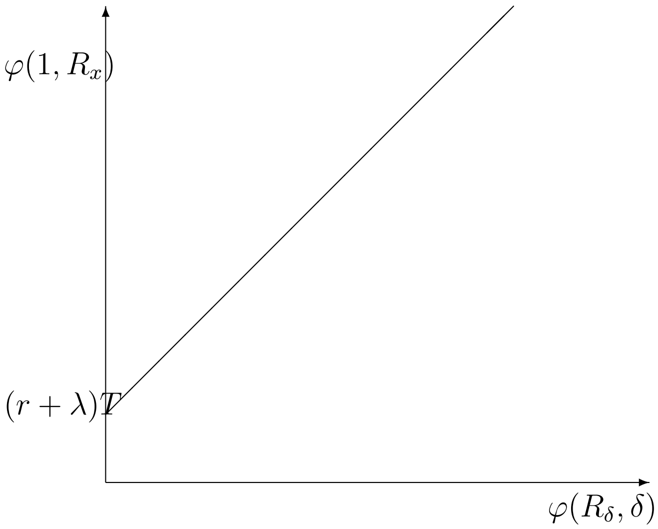
Notes: φ is the overall productivity of a match. δ is the degree of mismatch of a firm-worker pair, R_δ is the reservation productivity given δ. $\theta \equiv \frac{v}{u}$ is labour market tightness; LD is labour demand.

Figure A.3: Determination of the level of unemployment



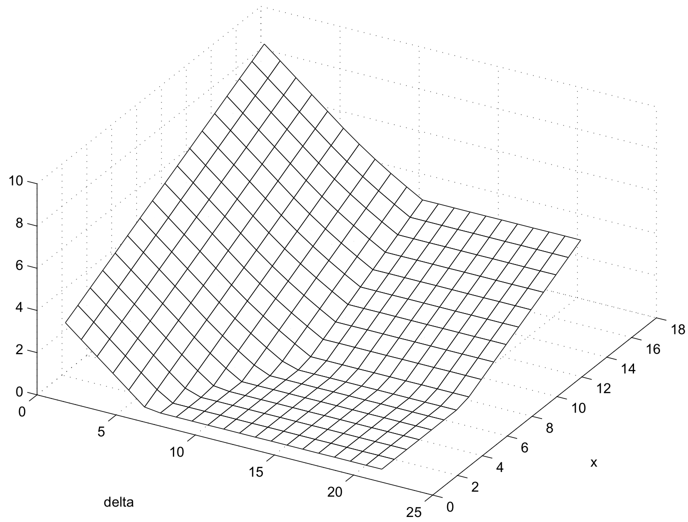
Notes: v are vacancies, u is the unemployment rate. *LD* is labour demand, *BC* denotes the Beveridge curve.

Figure A.4: The reservation productivities



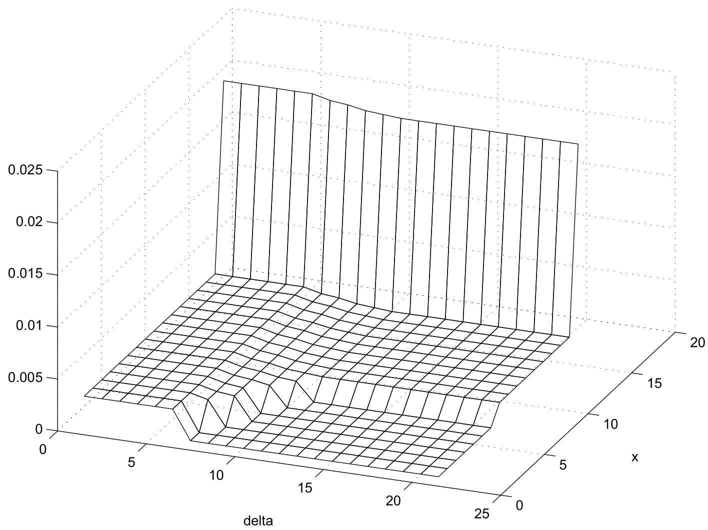
Notes: φ is the overall productivity of a match, δ the degree of mismatch of a firm-worker pair, x its idiosyncratic productivity, and R_x and R_δ are the reservation productivities given x and δ, respectively. r denotes the interest rate, λ the shock arrival rate. T are firing costs.

Figure A.5: Surplus for $T = 0$, $\rho = 0$, $\alpha = 0.5$



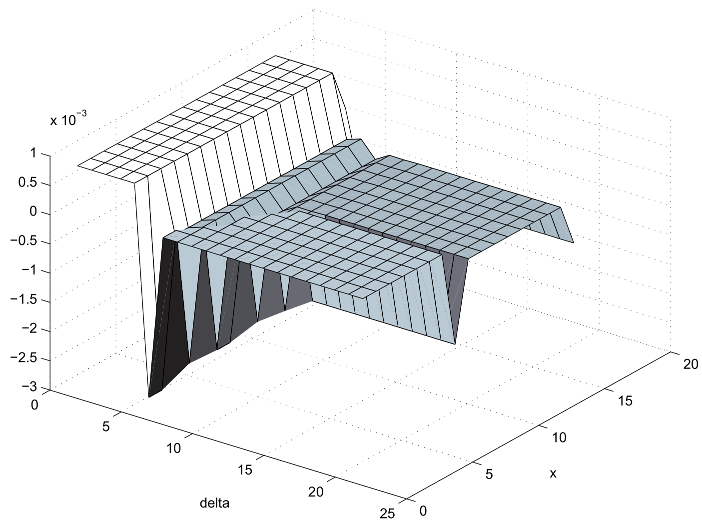
Notes: δ is the degree of mismatch of a firm-worker pair, x its idiosyncratic productivity. T are firing costs, ρ the replacement rate, α the mismatch parameter for the aggregate economy.

Figure A.6: Employment for $T = 0$, $\rho = 0$, $\alpha = 0.5$



Notes: δ is the degree of mismatch of a firm-worker pair, x its idiosyncratic productivity. T are firing costs, ρ the replacement rate, α the mismatch parameter for the aggregate economy.

Figure A.7: Change in employment when raising the replacement rate



Notes: δ is the degree of mismatch of a firm-worker pair, x its idiosyncratic productivity. Parameter values: firing costs $T = 0$, mismatch in the aggregate economy $\alpha = 0$; the replacement rate is raised from $\rho = 0$ to $\rho = 0.2$.

A.2.3 Tables

Table A.2: Unemployment rates at different levels of replacement rate and firing costs for $\alpha = 0.85$

		T=					
		0	0.5	1	1.5	2	2.5
	0	4.68	4.68	4.71	4.73	4.75	4.78
	0.1	4.78	4.94	4.96	4.99	5.01	5.04
$\rho =$	0.2	5.01	5.20	5.23	5.25	5.28	5.31
	0.3	5.20	5.51	5.54	5.57	5.60	5.63
	0.4	5.53	5.87	5.92	5.96	5.99	6.03
	0.5	6.00	6.20	6.27	6.31	6.47	6.53

Notes: T are firing costs, ρ the replacement rate, α mismatch in the aggregate economy.

A.2.4 Proofs

Option values

This section presents the derivation of the option values of unemployed workers and of firms offering a vacancy. First, I show how to represent expectations over functions of two random variables by using established theorems from measure and integration theory. I then apply these results in order to obtain the option values.

Let X and Y be two random variables, and let $(\Omega, \mathcal{F}, \mathcal{P})$ be a measure space where $\Omega = \Omega_1 \times \Omega_2$ is a product space, $\mathcal{F} = \mathcal{F}_1 \times \mathcal{F}_2$ a Borel field of subsets of Ω, and $\mathcal{P} = \mathcal{P}_1 \times \mathcal{P}_2$ a measure on $\mathcal{F}$. Furthermore, let (X, Y) on $(\Omega, \mathcal{F}, \mathcal{P})$ induce the probability space $(\Omega, \mathcal{F}, \mu)$, where $\mu = \mu_x \times \mu_y$ is a probability measure. Note that μ_x (μ_y) is the probability measure induced by X (Y). Finally, let f be a function of two variables which is Borel measurable with respect to $\mathcal{F}_1 \times \mathcal{F}_2$. Then (for a proof, see Chung, 2001, Section 3.2):

$$\int_\Omega f(X(\omega), Y(\omega))\mathcal{P}(d\omega) = \int\int_{\Omega_1 \times \Omega_2} f(x, y)\mu_x \times \mu_y(dx, dy)$$

where $\omega \in \Omega$, and $X(\omega)$ $(Y(\omega))$ and x (y) are realisations of X and Y, respectively. Suppose that, in addition to the above assumptions, f is integrable with respect to $\mu_x \times \mu_y$. Then, Fubini's theorem holds. One therefore gets the following relation between a double integral and a repeated integral (see

Chung, 2001, p. 63):

$$\int\int_{\Omega_1\times\Omega_2} f(x,y)\mu_x \times \mu_y(dx,dy) = \int_{\Omega_1}\left[\int_{\Omega_2} f(x,y)\mu_y dy\right]\mu_x dx \tag{A.1}$$

To obtain the worker's option value, I proceed as follows. Let F and G_2 denote the distribution functions induced by X and Y, and let sf denote the realisation of random variable Y. The right-hand side of equation (A.1) then reads $\int_{\Omega_1}\left[\int_{\Omega_2} f(x,sf)dG_2(sf)\right]dF(x)$. Now, setting $\Omega_1 = \Omega_2 = [0,1]$ and replacing the function f with the worker's maximisation problem yields his option value when unemployed: $\int_0^1\int_0^1 max(W^o_{sw}(x',sf'),U_{sw})dF(x')dG_2(sf')]$. The firm's option value can be derived similarly.

Deriving the expressions for the value functions and wages

Let Δ denote the length of a time interval, $e^{-r\Delta}$ the corresponding discount factor, and $l(k,\Delta)$ the probability of obtaining k job offers within time interval Δ. Then, one can write the value of unemployment as

$$\begin{aligned} U_{sw}\Delta &= (1-\tau)\cdot b\Delta + e^{-r\Delta}[l(0,\Delta)U_{sw} \\ &\quad +l(1,\Delta)\int_0^1\int_0^1 max(W^o_{sw}(x',sf'),U_{sw})dF(x')dG_2(sf') \\ &\quad +\sum_{k=2}^{\infty} l(k,\Delta)\int_0^1\int_0^1 max(W^o_{sw}(x',sf'),U_{sw})dF(x')dG_2(sf')] \\ &= (1-\tau)\cdot b\Delta + e^{-r\Delta}[U_{sw} + l(1,\Delta)\Xi + \sum_{k=2}^{\infty} l(k,\Delta)\Xi \end{aligned}$$

where $\Xi \equiv \int_0^1\int_0^1 max\{W^o_{sw}(x',sf') - U_{sw}, 0\}dF(x')dG_2(sf')]$. It follows:

$$\begin{aligned} \frac{(1-e^{-r\Delta})U_{sw}}{\Delta} &= (1-\tau)\cdot b \\ &\quad +e^{-r\Delta}[\frac{l(1,\Delta)}{\Delta}\Xi + \sum_{k=2}^{\infty}\frac{l(k,\Delta)}{\Delta}\Xi] \end{aligned} \tag{A.2}$$

where Ξ is defined as above. Taking the limit as $\Delta \to 0$, and noting that $\lim_{\Delta\to 0}\frac{1-e^{-r\Delta}}{\Delta} = r$, $\lim_{\Delta\to 0} l(0,\Delta) = 1$, and $\lim_{\Delta\to 0} l(1,\Delta) = \lambda$, yields

$$rU_{sw} = (1-\tau)\cdot b + \lambda\Xi \tag{A.3}$$

With free entry (equation (2.7)) and the first-order condition from the Nash bargain for outside wages (equation (2.8)), it follows:

$$(1-\tau)\frac{\beta}{1-\beta}\frac{c}{q(\theta)} \quad = \quad (1-\beta)\Xi$$

Inserting this result in (2.6) and using Lemma 1, one obtains

$$rU_{sw} = (1-\tau)\cdot b + (1-\tau)\frac{\beta}{1-\beta}\theta c \tag{A.4}$$

Plugging the corresponding value functions into the FOC of the Nash bargain yields:

$$\begin{aligned}
&\frac{(1-\tau)\beta}{r+\lambda}[\varphi(x,sf,sw) - w^o(x,sf,sw) \\
&+\lambda\int_0^1 max\{J_{sf}(x',sw)+T,0\}dF(x') - \lambda T] \\
&= \frac{1-\beta}{r+\lambda}[(1-\tau)w^o(x,sf,sw) \\
&+\lambda\int_0^1 max\{W_{sw}(x',sf),U_{sw}\}dF(x') - (r+\lambda)U_{sw}
\end{aligned}$$

Using the FOC of the Nash bargain for the expected values, an expression for the wage is obtained:

$$w^o(x,sf,sw) = \beta[\varphi(1,sf,sw) - \lambda T] + \frac{1-\beta}{1-\tau}rU_{sw}$$

This result, together with (A.4) implies

$$w^o(x,sf,sw) = (1-\beta)\cdot b + \beta[\varphi(x,sf,sw) + \theta c - \lambda T] \tag{A.5}$$

The inside wage, $w(x,sf,sw)$, can be derived in a similar way.

Proof of Lemma 3

$$\int_0^1\int_0^1\int_0^1 \varphi(x,sf,sw)dF(x)dG_1(sw)dG_2(sf) = \int_0^1\int_0^1 \varphi(x,\delta)dF(x)dG(\delta)$$

Proof.

$$\begin{aligned}\int_0^1\int_0^1\int_0^1 & \varphi(x,sf,sw)dF(x)dG_1(sw)dG_2(sf) \\ &= \int_0^1\int_0^1\int_0^1 \varphi(x,sf,sw)dG_1(sw)dG_2(sf)dF(x) \\ &= \int_0^1\int_0^1 \varphi(x,\delta)dG(\delta)dF(x) \\ &= \int_0^1\int_0^1 \varphi(x,\delta)dF(x)dG(\delta).\end{aligned}$$

where the second equality follows from the fact that, because sf and sw are stochastically independent random variables and because they share a common support $[0,1]$, δ is a random variable as well (cf. Chung, 2001, Theorem 3.1.5.). I call the distribution function governing this random variable $G(\delta)$. The other two equalities follow from Fubini's Theorem (Cf. Chung, 2001, p. 63). □

The reservation rules

Here, I show that the reservation productivity depends upon x and δ only, and that the corresponding reservation values for x and δ exist and are unique. To see this, first note that, because of Nash bargaining over wages, firms and workers agree on both match formation and separation. Now, insert the expressions for the outside and the inside wages, equations (2.10) and (2.11), into the corresponding value functions, equations (2.1) and (2.2), and equations (2.4) and (2.5), and make use of Theorem 1:

$$\begin{aligned}J^o(x,\delta) &= \frac{1}{r+\lambda}[(1-\beta)(\varphi(x,\delta)-b)-\beta[\theta c-\lambda T] \\ &\quad +\lambda\int_0^1 max\{J(x',\delta),-T\}dF(x')] \qquad \text{(A.6)} \\ J(x,\delta) &= \frac{1}{r+\lambda}[(1-\beta)[\varphi(x,\delta)-b]-\beta[\theta c+rT] \\ &\quad +\lambda\int_0^1 max\{J(x',\delta),-T\}dF(x')] \qquad \text{(A.7)}\end{aligned}$$

$$\begin{aligned} W^o(x,\delta) &= \frac{1}{r+\lambda}[(1-\tau)(1-\beta)b + (1-\tau)\beta[\varphi(x,\delta)+\theta c - \lambda T] \\ &\quad +\lambda \int_0^1 max\{W(x',\delta),U\}dF(x')] \\ W(x,\delta) &= \frac{1}{r+\lambda}[(1-\tau)(1-\beta)b + (1-\tau)\beta[\varphi(x,\delta)+\theta c + rT] \\ &\quad +\lambda \int_0^1 max\{W(x',\delta),U\}dF(x')] \end{aligned}$$

The right-hand side is a contraction which is mapping the space of linear functions in x into itself. As can readily be verified, the contraction is of modulus $\epsilon < 1$. One therefore obtains a unique fixed point for each equation (cf. Stokey et al., 1989, Theorem 3.2.) As the four fixed points are strictly increasing in x and $1-\delta$, the reservation values will be unique, yielding two upper bounds for x and $1-\delta$. For notational reasons, I replace the *upper* bound for $1-\delta$ with a *lower* bound for δ.

The equilibrium conditions

In order to derive the job creation condition, I proceed as follows.[1] Substitute equations (2.10) and (2.11) into the expressions for J^o and J, respectively, and R_δ for x in the latter expression. This yields

$$\begin{aligned} (r+\lambda)J^o(1,\delta) &= (1-\beta)(\varphi(1,\delta)-b) - \beta\theta c + \beta\lambda T \\ &\quad +\lambda \int_{R_\delta}^1 J(x',\delta)dF(x') - F(R_\delta)T \\ (r+\lambda)J(R_\delta,\delta) &= (1-\beta)(\varphi(R_\delta,\delta)-b) - \beta\theta c - \beta r T \\ &\quad +\lambda \int_{R_\delta}^1 J(x,\delta)dF(x') - F(R_\delta)T \end{aligned}$$

Subtracting the second equation from the first, one gets

$$(r+\lambda)(J^o(1,\delta) - J(R_\delta,\delta)) = (1-\beta)(\varphi(1,\delta)-\varphi(R_\delta,\delta)) + \beta\lambda T + \beta r T \quad \text{(A.8)}$$

Integrating over δ and noting that $\int_0^{R_x} J^o(1,\delta')dG(\delta') = \frac{c}{q(\theta)}$, and $J(R_\delta,\delta) = -T$, one obtains the job creation condition:

$$\frac{c}{q(\theta)} = \frac{(1-\beta)}{r+\lambda}\int_0^{R_x}[\varphi(1,\delta')-\varphi(R_\delta,\delta')]dG(\delta') - (1-\beta)T$$

[1]This section draws on Cahuc and Zylberberg (2004).

I derive the reservation productivity condition in the following way. I set $\delta = R_x^o$ and $x = R_\delta$ in the equations for J^o and J, respectively. Noting that $J^o(1, R_x^o) = 0$ and $J(R_\delta, \delta) = -T$ while subtracting the two equations from each other, one obtains the requested condition:

$$\varphi(1, R_x^o) - \varphi(R_\delta, \delta) = (r + \lambda)T$$

Setting $\delta = R_x^o$ and noting that $S(1, R_x^o) = 0$, one gets

$$\begin{aligned} 0 &= \varphi(1, R_x) - \tau w^o(1, R_x^o) \\ &\quad +\lambda \int_0^1 max\{W(x', \delta) - J(x', \delta) - U, -T\} dF(x') - \lambda T - rU \end{aligned} \quad \text{(A.9)}$$

In order to obtain the condition for tightness, set $\delta = R_x^o$ in the value function for a worker's initial job and note that $W^o(1, R_x^o) = W(R_\delta, \delta) = U$ yields

$$rU = (1 - \tau)w^o(1, R_x) + \lambda \int_0^1 max\{W(x', R_x) - U, 0\} dF(x') \quad \text{(A.10)}$$

Furthermore, note that here, because of the continuity of the distribution function $F(.)$, $\int_0^1 (W(x', R_x) - U) dF(x') < 0$ almost everywhere, i.e.

$$\int_0^1 max\{W(x', R_x) - U, 0\} dF(x') = 0.$$

This means that when a match starts with $x = 1$ and the corresponding value for R_x, then the option value of this match is zero, because at the next shock to x, the match is going to be destroyed. Using this fact together with equations (2.10), (A.4), and (A.10), after some manipulation yields the tightness condition:

$$\varphi(1, R_x) = b + \frac{\beta}{1 - \beta} \theta c + \lambda T \quad \text{(A.11)}$$

A.3 Appendix to Chapter 3

A.3.1 Tables

Table A.3: Cross-sectional properties of separation flows

	As share of employment				As share of sep.		
	Sep.	**EE**	**EU**	**EN**	**EE**	**EU**	**EN**
All obs.	2.21	0.71	0.58	0.92	32.1	26.2	41.6
By age							
16-24	4.82	1.44	1.14	2.25	29.9	23.6	46.7
25-29	2.85	1.03	0.72	1.11	36.1	25.2	38.8
30-34	2.19	0.82	0.54	0.84	37.3	24.6	38.3
35-39	1.70	0.67	0.44	0.59	39.4	25.9	34.7
40-44	1.42	0.57	0.39	0.46	40.1	27.5	32.4
45-49	1.26	0.47	0.38	0.41	37.3	30.2	32.5
50-54	1.23	0.39	0.40	0.44	31.7	32.5	35.8
55+	2.16	0.30	0.55	1.31	13.9	25.5	60.6
By sex, age 25-55							
Male	1.72	0.71	0.49	0.52	41.3	28.5	30.2
Female	1.95	0.61	0.49	0.85	31.3	25.1	43.6
By industry, age 25-55							
Agr., Energy, Mining	1.61	0.50	0.55	0.55	31.1	34.3	34.3
Production	1.29	0.52	0.36	0.41	40.3	27.9	31.8
Construction	2.98	0.79	1.42	0.77	26.5	47.7	25.8
Trade, transport	2.19	0.90	0.50	0.79	41.1	22.8	36.1
Services	2.13	0.75	0.47	0.90	35.3	22.2	42.3
State	1.25	0.45	0.33	0.48	35.6	26.2	38.2
By education, age 25-55							
no vt, no Abi	2.04	0.55	0.69	0.79	27.1	33.9	38.7
vt, no Abi	1.61	0.64	0.43	0.54	39.8	26.7	33.5
no vt, Abi	2.82	0.84	0.41	1.56	29.8	14.5	55.3
vt, Abi	1.94	0.86	0.34	0.75	44.3	17.4	38.6
polytec	1.35	0.75	0.21	0.39	55.6	15.5	28.9
university	2.09	0.88	0.32	0.88	42.2	15.3	42.2
By working time							
Part-time, with UI	1.97	0.53	0.44	0.99	26.9	22.4	50.4
Full time	1.79	0.69	0.49	0.61	38.5	27.4	34.1

Notes for Table A.3

Data are from IABS-R01 and author's calculations. Underlying flows calculated cumulatively for 1980-2000 and expressed as monthly averages. *vt* denotes vocational training, *Abi* Abitur (high-school degree), and *polytec* and *university* stand for a degree from a technical and a regular university, respectively. *UI* denotes unemployment insurance.

Table A.4: Mean and standard deviation of monthly worker flows

	EE	EU	EN	UE	NE	NU	UN
$\overline{x}$	0.66	0.53	0.85	0.44	0.95	0.26	0.34
SD	0.58	0.26	0.34	0.19	0.64	0.06	0.08
SD/$\overline{x}$	0.88	0.49	0.40	0.43	0.67	0.23	0.24

Source: IABS-R01 and author's calculations.

Notes: Flows normalized by the labour force. $\overline{x}$ is the mean, SD the standard deviation of a flow. All flows calculated on a cumulative basis for 1980-2000 and expressed in per cent.

Table A.5: Correlations between labour market flows and GDP growth

EE	EU	EN	UE	NE	UN	NU
0.120	-0.152	-0.035	-0.223	0.071	0.395	0.138

Source: Mönch and Uhlig (2005), IABS-R01, and author's calculations.

Notes: Flows calculated cumulatively, correlations are at monthly frequency for 1980-2000.

Table A.6: Cross-correlations of the flows making up accessions and separations

Accession flows			
	EE	UE	NE
EE	1.00	-0.62	-0.80
UE	-0.62	1.00	-0.16
NE	-0.80	-0.16	1.00

Separation flows			
	EE	EU	EN
EE	1.00	-0.78	0.68
EU	-0.78	1.00	-0.27
EN	0.68	-0.27	1.00

Source: IABS-R01 and author's calculations.

Notes: Flows calculated cumulatively, correlations are yearly frequency for 1980-2000.

Table A.7: Logit regression results for $P(S|.)$

	Pooled		**Random Effects**		**Fixed Effects**	
Variable	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**
q2	0.063***	(0.007)	0.034***	(0.007)	-0.004	(0.007)
q3	0.211***	(0.007)	0.181***	(0.007)	0.110***	(0.007)
q4	0.802***	(0.006)	0.790***	(0.006)	0.759***	(0.006)
vt, no Abi	-0.363***	(0.005)	-0.394***	(0.005)	-0.206***	(0.009)
no vt, Abi	0.142***	(0.019)	0.269***	(0.023)	0.387***	(0.038)
vt, Abi	-0.445***	(0.012)	-0.471***	(0.014)	-0.450***	(0.023)
polytec	-0.549***	(0.013)	-0.621***	(0.015)	-0.860***	(0.028)
university	-0.415***	(0.011)	-0.442***	(0.013)	-0.789***	(0.029)
Age 30-35	-0.187***	(0.006)	-0.222***	(0.006)	-0.331***	(0.008)
Age 35-40	-0.355***	(0.007)	-0.419***	(0.007)	-0.601***	(0.009)
Age 40-45	-0.479***	(0.007)	-0.578***	(0.008)	-0.812***	(0.011)
Age 45-50	-0.535***	(0.008)	-0.671***	(0.009)	-0.967***	(0.012)
Age 50-55	-0.479***	(0.008)	-0.644***	(0.009)	-0.960***	(0.012)
Prod.	-0.246***	(0.012)	-0.264***	(0.014)	-0.316***	(0.028)
Constr.	0.246***	(0.013)	0.267***	(0.015)	0.234***	(0.030)
Trade	0.047	(0.012)	0.011	(0.014)	-0.117***	(0.028)
Services	-0.010	(0.012)	-0.002	(0.014)	-0.139***	(0.028)
State	-0.250***	(0.014)	-0.285***	(0.017)	-0.443***	(0.033)
Man	-0.041***	(0.006)	-0.078***	(0.005)	-	-
duration:						
2q-5q	-0.448***	(0.006)	-0.349***	(0.010)	0.083***	(0.007)
6q-10q	-1.045***	(0.007)	-0.843***	(0.010)	-0.790***	(0.008)
11q-20q	-1.385***	(0.007)	-1.107***	(0.010)	-0.070***	(0.008)
21q-30q	-1.763***	(0.008)	-1.455***	(0.011)	-0.140***	(0.010)
31q-50q	-1.852***	(0.008)	-1.465***	(0.009)	0.488***	(0.012)
50q+	-1.777***	(0.009)	-1.259***	(0.011)	1.867***	(0.015)
ΔGDP	-0.003*	(0.001)	-0.003**	(0.001)	-0.003**	(0.001)
Intercept	-1.355***	(0.013)	-1.491***	(0.016)	-	-
L	-999661		-999661		-719528	

No. of observations: 4,831,513 (pooled and r.e.); 4,174,223 (f.e.)

Base categories: Quarter: quartal1; Education: no vt, no Abi; Industry: Agr., Energy, Mining; Age: Alter2530; Duration: 1q. "Trade" includes Transport; L: Log-likelihood.

Significance levels: *: 10%, **: 5%, ***: 1%

Data: IABS-R01 and author's calculations.

Table A.8: Logit regression results for $P(LF|.)$

	Pooled		**Random Effects**		**Fixed Effects**	
Variable	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**
q2	-0.307***	(0.015)	-0.357***	(0.017)	-0.396***	(0.021)
q3	-0.309***	(0.014)	-0.367***	(0.016)	-0.404***	(0.020)
q4	-0.087***	(0.013)	-0.136***	(0.015)	-0.166***	(0.019)
vt, no Abi	0.304***	(0.009)	0.341***	(0.011)	0.140***	(0.018)
no vt, Abi	-0.780***	(0.038)	-0.817***	(0.046)	-0.364***	(0.068)
vt, Abi	0.185***	(0.024)	0.255***	(0.029)	0.258***	(0.045)
polytec	0.422***	(0.028)	0.568***	(0.035)	0.827***	(0.059)
university	0.011	(0.022)	0.074***	(0.028)	0.698***	(0.060)
Age 3035	0.366***	(0.012)	0.405***	(0.015)	0.091	(0.019)
Age 3540	0.528***	(0.014)	0.592***	(0.017)	0.215***	(0.025)
Age 4045	0.630***	(0.016)	0.740***	(0.017)	0.516***	(0.030)
Age 4550	0.578***	(0.017)	0.695***	(0.020)	0.624***	(0.033)
Age 5055	0.289***	(0.017)	0.353***	(0.020)	0.437***	(0.033)
Prod.	0.182***	(0.023)	0.303***	(0.030)	0.095*	(0.055)
Constr.	0.470***	(0.026)	0.555***	(0.033)	0.166***	(0.059)
Trade	0.191***	(0.024)	0.311***	(0.031)	0.118*	(0.055)
Services	-0.006	(0.024)	0.110***	(0.030)	0.088**	(0.055)
State	-0.104***	(0.029)	-0.060	(0.036)	-0.084	(0.064)
Man	0.364***	(0.009)	0.420***	(0.012)	-	-
durations:						
2q-5q	0.410***	(0.012)	0.405***	(0.014)	0.237**	(0.017)
6q-10q	0.250***	(0.014)	0.244***	(0.017)	0.013	(0.020)
11q-20q	0.095***	(0.014)	0.083***	(0.017)	-0.103***	(0.021)
21q-30q	-0.220***	(0.017)	-0.209***	(0.020)	-0.012***	(0.027)
31q-50q	-0.602***	(0.016)	-0.618***	(0.020)	-0.063***	(0.030)
50q+	-0.935***	(0.018)	-0.958***	(0.022)	0.302***	(0.040)
Δ GDP	0.002	(0.002)	0.003	(0.003)	0.005	(0.004)
Intercept	-0.209***	(0.027)	-0.454***	(0.034)	-	-
L	-181648		-182426		-54074	

No. of observations: 290,405 (pooled and r.e.); 148,824 (f.e.).
Base categories and significance levels as in Table A.7. “Trade” includes Transport; L: Log-likelihood.

Data: IABS-R01 and author’s calculations.

Table A.9: Logit regression results for $P(U|.)$

	Pooled		Random Effects		Fixed Effects	
Variable	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**
q2	0.079***	(0.024)	0.085***	(0.023)	0.040	(0.028)
q3	0.223***	(0.018)	0.223***	(0.023)	0.208***	(0.027)
q4	0.186***	(0.016)	0.192***	(0.020)	0.424***	(0.025)
vt, no Abi	-0.502***	(0.012)	-0.521***	(0.016)	-0.016	(0.023)
no vt, Abi	-0.743***	(0.063)	-0.751***	(0.085)	0.130	(0.134)
vt, Abi	-1.165***	(0.035)	-1.233***	(0.046)	-0.142**	(0.067)
polytec	-1.322***	(0.039)	-1.423***	(0.053)	-0.156**	(0.085)
university	-1.200***	(0.033)	-1.330***	(0.046)	-0.095	(0.096)
Alter3035	-0.094***	(0.015)	-0.167***	(0.021)	-0.168***	(0.028)
Alter3540	-0.094***	(0.018)	-0.196***	(0.023)	-0.281***	(0.034)
Alter4045	-0.053***	(0.019)	-0.190***	(0.026)	-0.392***	(0.041)
Alter4550	0.041**	(0.021)	-0.010*	(0.029)	-0.425***	(0.049)
Alter5055	0.177***	(0.021)	0.072***	(0.031)	-0.355***	(0.055)
Prod.	-0.296***	(0.031)	-0.153***	(0.046)	-0.080	(0.073)
Constr.	0.466***	(0.033)	0.620***	(0.050)	0.266***	(0.077)
Trade	-0.735***	(0.031)	-0.618***	(0.047)	-0.284***	(0.073)
Services	-0.650***	(0.031)	-0.618***	(0.047)	-0.393***	(0.074)
State	-0.501***	(0.038))	-0.510***	(0.057)	-0.460***	(0.088)
Man	-0.260***	(0.011)	-0.403***	(0.018)	-	-
durations:						
2q-5q	0.050***	(0.015)	0.035***	(0.019)	0.057***	(0.022)
6q-10q	-0.460***	(0.018)	-0.434***	(0.023)	-0.218***	(0.027)
11q-20q	-0.719***	(0.019)	-0.712***	(0.0243)	-0.378***	(0.030)
21q-30q	-0.717***	(0.023)	-0.722***	(0.030)	-0.564***	(0.040)
31q-50q	-0.781***	(0.024)	-0.803***	(0.032)	-0.698***	(0.047)
50q+	-0.996***	(0.030)	-1.082***	(0.039)	-1.011***	(0.072)
Δ GDP	-0.047***	(0.003)	-0.048***	(0.004)	-0.049***	(0.005)
Intercept	0.946***	(0.036)	0.906***	(0.052)	-	-
L	-110962		-105563		-29055	

No. of observations: 174,242 (pooled and r.e.); 77,817 (f.e.).

Base categories and significance levels as in Table A.7. “Trade” includes Transport; L: Log-likelihood.

Data: IABS-R01 and author’s calculations.

Table A.10: Tests for heterogeneity

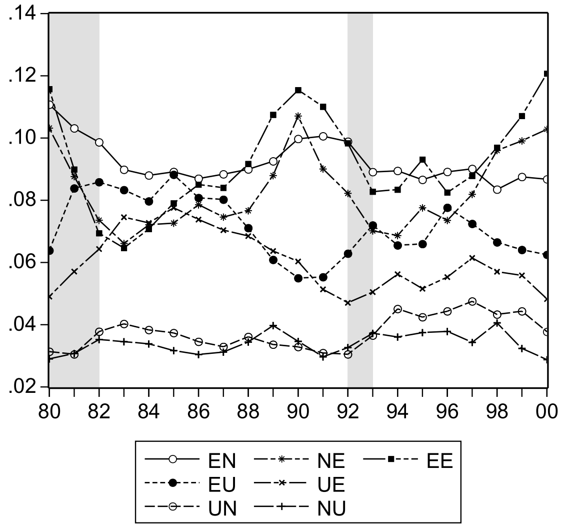
	$P(S \mid .)$	$P(LF \mid .)$	$P(U \mid .)$
LR	9179	7194	10797
Hausman	130733	4201	2028

Notes:

The likelihood ratio test (LR) compares the random effects model to the pooled model; the Hausman test compares the fixed effects model to the pooled model. The null hypothesis is homogeneity.

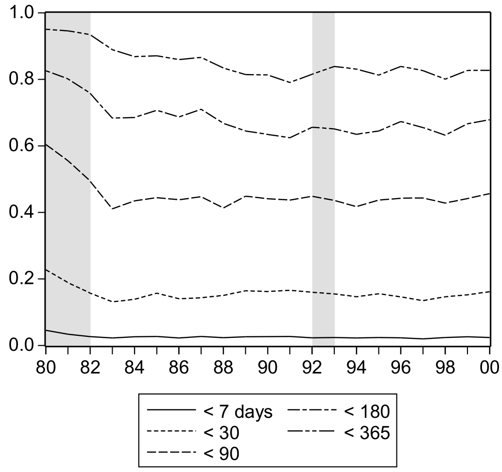
A.3.2 Figures

Figure A.8: The evolution of worker flows, 1980-2000



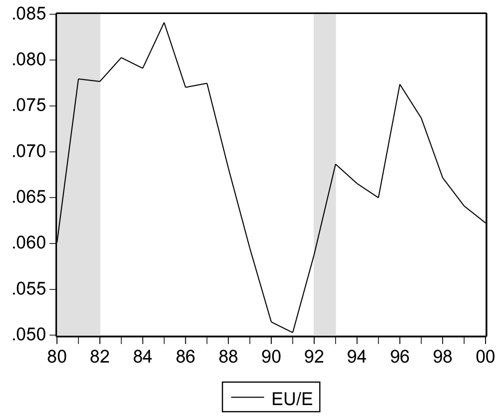
Source: IABS-R01 and author's calculations.
Notes: A flow XY indicates a transition from labour market state X to labour market state Y. The labour market states considered are dependent-status employment (E), unemployment (U), and non-participation (N). See the text for the precise definitions. All flows are cumulatively calculated, normalized by the labour force and expressed per annum. Shaded areas are times of recession.

Figure A.9: The share of different unemployment duration classes in total transitions from unemployment to employment, 1980-2000



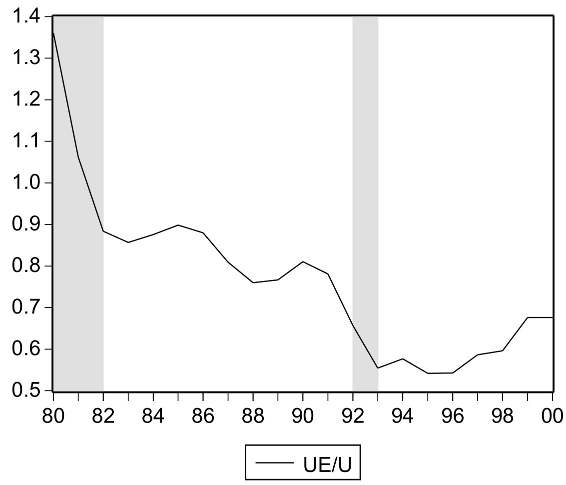
Source: IABS-R01 and author's calculations.
Notes: Transitions calculated cumulatively. Shaded areas are times of recession.

Figure A.10: The transition rate from employment to unemployment within a given year, 1980-2000



Source: IABS-R01 and author's calculations.
Notes: EU, the flow from employment to unemployment, is calculated cumulatively. E is dependent-status employment. Shaded areas are times of recession.

Figure A.11: The transition rate from unemployment to employment within a given year, 1980-2000.



Source: IABS-R01 and author's calculations.
Notes: UE, the flow from unemployment to employment, is calculated cumulatively. U is the state of unemployment as defined in the text. Shaded areas are times of recession.

Figure A.12: The Nagypal (2004) decomposition of becoming unemployed and ensuing worker flows

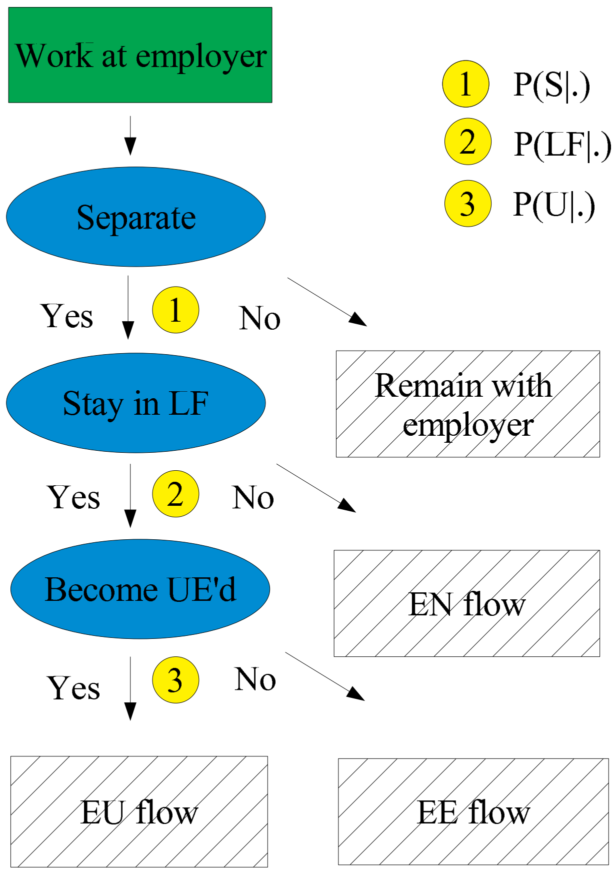
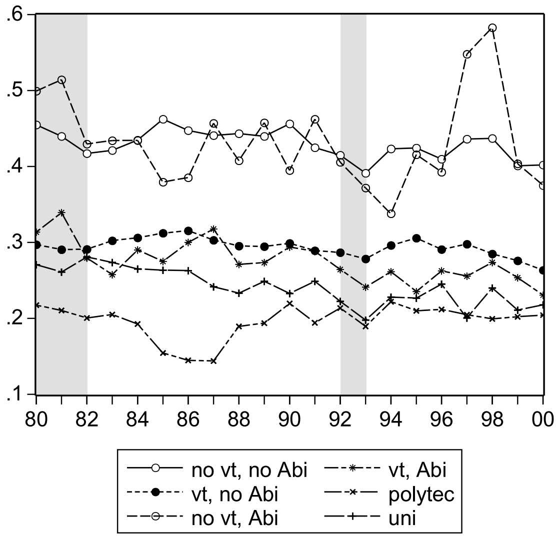
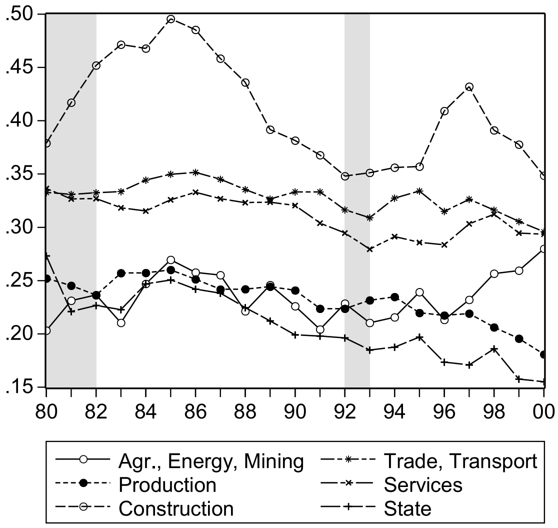


Figure A.13: Conditional probability of separation for workers with different education



Source: IABS-R01 and author's calculations.
Notes: vt denotes vocational training, Abi is Abitur; polytec, and uni indicate a degree from a polytechnical university and from a university, respectively. Shaded areas are times of recession.

Figure A.14: Conditional probability of separation for workers in different industrial sectors



Source: IABS-R01 and author's calculations.
Notes: Shaded areas denote times of recession.

A.4 Appendix to Chapter 4

A.4.1 Tables

Table A.11: Employment shares for 16 sectors for different time periods

	1976 -2000	76 -80	81 -85	86 -90	91 -95	96 -00
Agr., En., Min.	2.7	3.1	3.1	2.9	2.5	2.3
Prim./interm. good prod.	7.8	9.1	8.5	7.9	7.1	6.2
Prod.: investment goods 1	10.1	10.3	10.3	10.7	10.0	9.4
Prod.: investment goods 2	9.3	9.6	9.4	9.9	9.0	8.4
Consumption goods	7.4	8.9	8.1	7.5	6.8	5.8
Food, beverages, tobacco	3.2	3.5	3.4	3.3	3.2	2.9
Main construction trade	4.2	5.2	4.7	3.9	3.8	3.4
Construction (upgrading)	2.5	2.4	2.5	2.4	2.7	2.7
Distr. services 1	6.1	6.1	6.0	6.0	6.2	6.3
Distr. services 2	8.7	8.7	8.8	8.5	8.8	8.9
Transport, communication	4.5	4.6	4.5	4.3	4.4	4.5
Services, business-related	10.3	7.9	8.8	9.8	11.4	13.5
Services, household-related	3.7	3.5	3.7	3.8	3.7	3.9
Services: social 1	8.3	6.8	7.5	8.1	9.1	10.1
Services: social 2	4.1	3.0	3.5	4.0	4.6	5.5
Public services	6.9	7.1	7.2	7.1	6.7	6.4

Source: IABS-R01 and authors' calculations.
Notes: Figures in per cent. Distributive services 1 (2) includes wholesale trade (retail trade); Services: social 1 (2) includes hospitals (organisations); "Public services" includes government services and social insurance.

Table A.12: Flows as share of the social security labor force

	1981 -2000	1981 -85	1985 -90	1991 -95	1996 -2000
Sectoral inflows	20.3	19.1	21.6	18.5	21.9
0.5*(EEI+EEX)	3.6	2.8	4.0	3.8	4.0
UE	5.3	5.8	5.8	4.6	5.1
NE	11.3	10.4	11.8	10.2	12.8
Sectoral outflows	20.2	20.1	19.8	19.2	21.6
EU	6.4	7.4	6.1	5.7	6.3
EN	10.2	9.9	9.7	9.7	11.3

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. Annual figures in per cent.

Table A.13: The consumption goods sector: Different flow measures as share of employment

	1981 -2000	1981 -85	1985 -90	1991 -95	1996 -2000
Sectoral inflows	18.7	17.3	21.0	16.9	19.4
EEI	3.4	2.3	3.9	3.5	3.8
UE	5.4	5.5	6.0	5.0	5.1
NE	9.9	9.5	11.1	8.5	10.5
Sectoral outflows	20.7	20.4	20.4	20.8	21.4
EEX	3.7	2.7	4.1	4.0	3.8
EU	7.6	8.5	6.9	7.5	7.5
EN	9.5	9.2	9.4	9.3	10.1
Gross flows	35.9	35.2	37.4	34.0	37.0
0.5*(EEI+EEX)	3.5	2.5	4.1	3.8	3.8
UE+EU	13.0	14.1	12.9	12.5	12.5
NE+EN	19.4	18.6	20.4	17.8	20.6
Net flows, yearly basis	2.5	3.1	1.3	3.8	1.9
$\|EEI - EEX\|$	0.3	0.4	0.2	0.5	0.2
$\|UE - EU\|$	2.3	3.0	1.1	2.6	2.4
$\|NE - EN\|$	1.1	0.7	1.7	1.0	0.8

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. Annual figures in per cent.

Table A.14: The business-related service sector: Different flow measures as share of employment

	1981 -2000	1981 -85	1985 -90	1991 -95	1996 -2000
Sectoral inflows	25.7	21.3	26.9	24.3	31.4
EEI	4.8	3.7	4.9	5.1	5.4
UE	5.0	4.4	5.1	4.5	6.0
NE	15.9	13.2	15.9	14.7	20.0
Sectoral outflows	22.9	20.6	21.7	21.8	27.4
EEX	4.7	3.4	5.1	4.8	5.6
EU	5.1	5.5	4.6	4.6	5.7
EN	13.1	11.8	12.0	12.4	16.0
Gross flows	43.8	38.4	42.6	41.1	53.3
0.5*(EEI+EEX)	4.7	3.5	5.0	5.0	5.5
UE+EU	10.1	9.9	9.7	9.1	11.8
NE+EN	29.0	25.0	27.9	27.1	36.0
Net flows	2.9	0.7	4.2	2.5	4.0
$\|EEI - EEX\|$	0.3	0.3	0.2	0.4	0.3
$\|UE - EU\|$	0.7	1.0	0.7	0.4	0.7
$\|NE - EN\|$	2.9	1.5	3.9	2.2	4.0

Source: IABS-R01 and authors' calculations.
Notes: EEI and EEX are direct job-to-job transitions associated with a sectoral inflow and outflow, respectively. UE and NE are sectoral employment inflows from unemployment and non-participation, respectively. EU and EN are sectoral employment outflows to unemployment and non-participation, respectively. Annual figures in per cent.

Table A.15: Sectoral inflow and outflow rates for different time periods

	1976 -2000	1976 -80	1981 -85	1985 -90	1991 -95	1996 -2000
Inflow rate						
Agr., En., Min.	9.93	10.45	9.74	9.62	8.56	11.24
Production	9.69	10.59	9.06	10.69	8.41	9.66
Construction	14.28	15.05	12.92	14.70	13.57	14.59
Trade, Transp.	15.37	17.15	13.68	15.11	14.83	15.63
Services	16.49	17.57	15.01	16.13	15.74	17.76
State	10.97	11.97	10.62	11.59	10.07	10.41
Outflow rate						
Agr., En., Min.	13.53	12.84	13.02	12.63	12.74	16.46
Production	11.13	11.18	11.05	10.30	11.82	11.35
Construction	21.14	19.17	25.07	21.72	18.05	22.68
Trade, Transp.	15.94	17.18	15.79	15.06	15.50	16.27
Services	15.50	15.91	15.14	14.90	14.75	16.79
State	11.99	12.56	11.54	11.86	11.60	12.41

Source: IABS-R01 and authors' calculations.
Notes: The inflow and outflow rate are calculated as sectoral employment inflows and outflows divided by the employment stock, respectively. Annual averages calculated from yearly panel. Figures in per cent.

Table A.16: Sectoral inflow rates for different time periods

	1976 -2000	1976 -80	1981 -85	1985 -90	1991 -95	1996 -00
Agr., En., Min.	9.9	10.5	9.7	9.6	8.6	11.2
Prim./Interm. good prod.	9.2	9.7	8.2	10.3	8.4	9.6
Prod.: investment goods 1	9.8	11.2	9.2	10.9	8.0	9.5
Prod.: investment goods 2	11.3	11.9	10.6	12.8	9.7	11.6
Consumption goods	12.4	14.0	11.3	13.2	11.3	12.2
Food, beverages, tobacco	22.7	29.0	21.5	23.9	19.1	20.0
Main construction trade	13.4	13.9	11.7	14.0	12.9	14.4
Construction (upgrading)	17.1	19.3	16.6	18.5	15.5	15.9
Distr. services 1	17.0	19.3	15.0	17.0	16.9	16.8
Distr. services 2	18.1	21.0	16.5	18.2	17.1	17.6
Transport, communication	14.3	14.4	12.0	14.6	14.2	16.5
Services, business-related	16.2	15.8	13.9	16.1	16.3	19.1
Services, household-related	22.5	24.5	22.4	23.5	19.9	22.2
Services: social 1	16.1	18.4	14.8	15.6	15.3	16.5
Services: social 2	18.5	19.8	16.4	17.9	18.5	19.5
Public services	10.5	11.5	10.1	11.2	9.7	10.1

Source: IABS-R01 and authors' calculations.
Notes: Sectoral inflow rates are sectoral inflows divided by the respective employment stock. Annual averages calculated from yearly panel. Figures in per cent. Distributive services 1 (2) includes wholesale trade (retail trade); Services: social 1 (2) includes hospitals (organisations); "Public services" includes government services and social insurance.

Table A.17: Sectoral outflow rates for different time periods

	1976 -2000	1976 -80	1981 -85	1985 -90	1991 -95	1996 -00
Agr., En., Min.	11.8	10.9	10.9	10.9	11.2	14.9
Prim./interm. good prod.	10.8	10.6	10.2	10.1	11.3	11.9
Prod.: investment goods 1	10.0	10.4	9.7	9.1	11.0	9.9
Prod.: investment goods 2	11.7	11.7	11.2	11.1	12.7	12.1
Consumption goods	14.0	14.4	13.7	13.1	14.4	14.2
Food, beverages, tobacco	15.6	17.0	14.3	15.7	15.0	16.0
Main construction trade	15.2	13.9	16.3	14.1	13.9	17.8
Construction (upgrading)	16.7	18.0	17.9	16.0	14.6	16.8
Distr. services 1	16.5	18.3	15.8	15.6	16.2	16.8
Distr. services 2	18.3	20.2	18.1	17.3	17.4	18.5
Transport, communication	14.5	14.8	13.5	13.7	14.9	15.6
Services, business-related	14.1	13.8	13.1	13.3	14.2	16.2
Services, household-related	22.1	23.4	22.6	22.4	20.2	21.8
Services: social 1	14.9	15.8	14.3	13.8	14.0	16.4
Services: social 2	16.5	16.9	14.7	16.3	16.2	18.5
Public services	11.5	11.9	11.0	11.3	11.2	12.1

Source: IABS-R01 and authors' calculations.
Notes: Sectoral outflow rates are sectoral outflows divided by the respective employment stock. Annual averages calculated from yearly panel. Figures in per cent. Distributive services 1 (2) includes wholesale trade (retail trade); Services: social 1 (2) includes hospitals (organisations); "Public services" includes government services and social insurance.

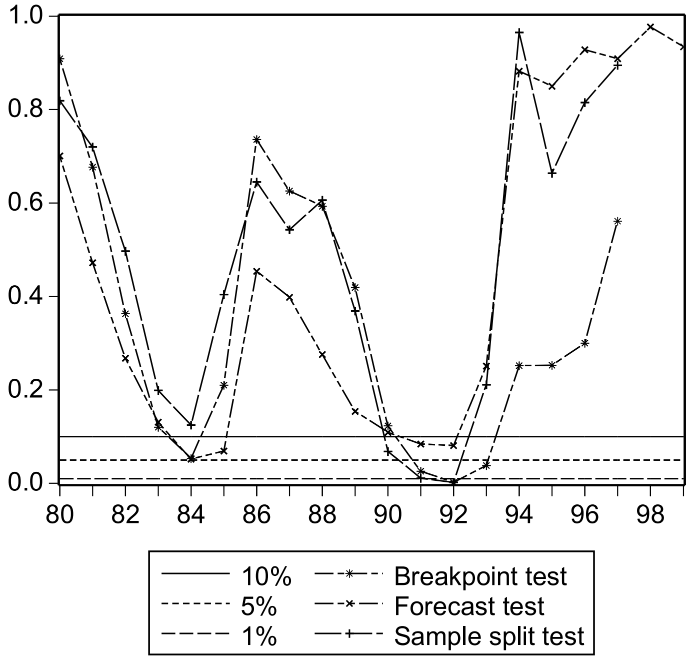
Table A.18: Changes in sectoral employment shares

	1976 -2000	1976 -80	1981 -85	1985 -90	1991 -95	1996 -00
Agr., En., Min.	1.5	1.3	1.5	0.8	2.4	1.7
Prim./interm. good prod.	1.9	0.8	1.9	1.6	2.9	2.3
Prod.: investment goods 1	1.9	0.7	1.7	2.5	3.2	1.6
Prod.: investment goods 2	2.4	0.8	2.8	2.5	3.3	2.4
Consumption goods	1.9	0.7	2.8	1.4	3.3	1.6
Food, beverages, tobacco	1.5	0.7	1.1	2.0	1.4	2.3
Main construction trade	3.0	2.8	5.1	2.7	1.2	2.9
Construction (upgrading)	2.3	1.5	2.3	4.0	2.3	1.5
Distr. services 1	1.9	1.3	1.1	2.9	1.4	2.7
Distr. services 2	2.0	1.7	1.1	2.9	1.3	3.1
Transport, communication	2.3	1.6	1.7	2.5	1.8	4.0
Services, business-related	3.8	2.8	1.1	4.8	3.4	7.1
Services, household-related	2.9	1.7	0.9	4.0	1.2	6.6
Services: social 1	3.2	3.7	1.3	3.6	3.3	4.3
Services: social 2	4.1	4.1	2.9	3.9	4.4	4.1
Public services	1.0	0.9	0.6	1.1	1.0	1.5

Source: IABS-R01 and authors' calculations.
Notes: Annual averages in per cent. Distributive services 1 (2) includes wholesale trade (retail trade); Services: social 1 (2) includes hospitals (organisations); "Public services" includes government services and social insurance.

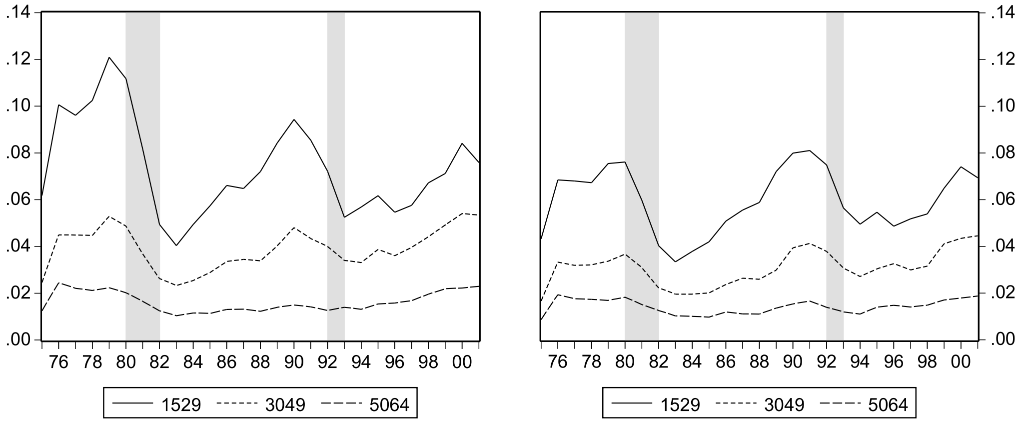
A.4.2 Figures

Figure A.15: p-values of Chow-type stability tests for the productive sector



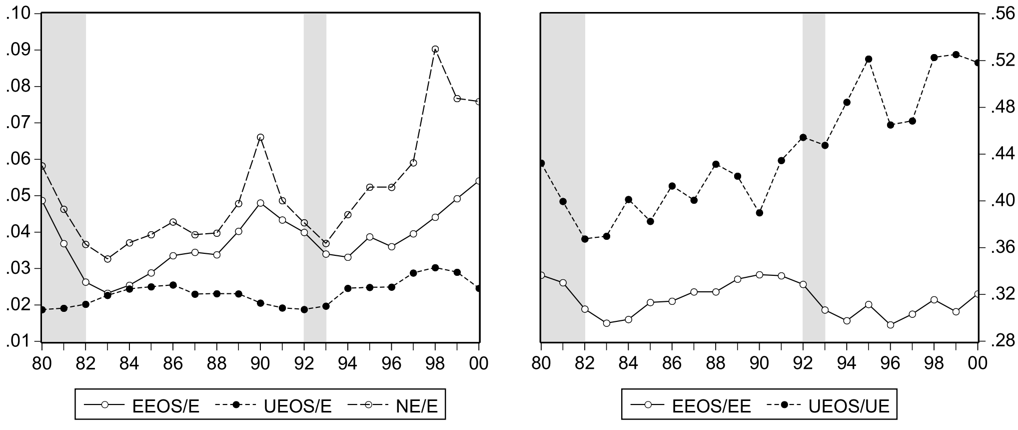
Source: IABS-R01 and authors' calculations.
Notes: p-values are bootstrapped and computed with JMulTi 4.15 (cf. Lütkepohl and Krätzig, 2004) using 1000 replications.

Figure A.16: Probability of experiencing a job-to-job transition together with a change of sector for different age groups and men (left panel) and women (right panel)



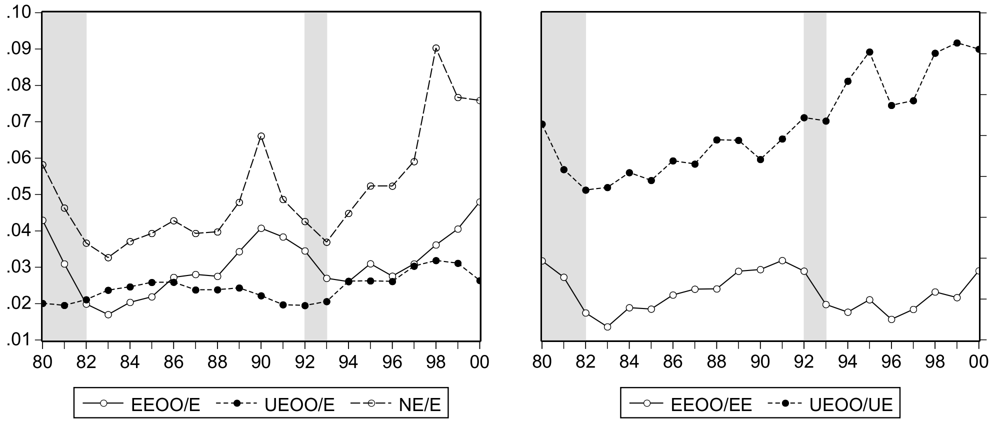
Source: IABS-R01 and authors' calculations.

Figure A.17: Labor market transitions normalized by the employment stock (left panel), and fraction involving a change of sector conditional on a certain labor market transition (right panel)



Source: IABS-R01 and authors' calculations.
Notes: EE are all direct job-to-job transitions, UE and NE all transitions from unemployment and non-participation to employment, respectively. EEOS and UEOS are the direct job-to-job transitions and transitions from unemployment to employment associated with a sectoral change. Yearly figures for male employees aged 30-49.

Figure A.18: Fraction of new employment relationships involving a change of occupation and a certain labor market transition (left panel), and fraction involving a change of occupation conditional on a certain labor market transition (right panel)



Source: IABS-R01 and authors' calculations.
Notes: EE are all direct job-to-job transitions, UE and NE all transitions from unemployment and non-participation to employment, respectively. EEOO and UEOO are the direct job-to-job transitions and transitions from unemployment to employment associated with a change of occupation. Yearly figures for male employees aged 30-49.

Selbständigkeitserklärung

Hiermit erkläre ich, dass ich außer von den in der Danksagung genannten Personen keine weitere Hilfe von anderen Personen bei der Abfassung der Dissertation erhalten habe. Darüber hinaus habe ich außer der angeführten Literatur und den in der Dissertation angegebenen Hilfsmitteln keine weiteren Hilfsmittel verwendet. Ich bezeuge durch meine Unterschrift, dass meine Angaben über die bei der Abfassung meiner Dissertation benutzten Hilfsmittel, über die mir zuteil gewordene Hilfe sowie über frühere Begutachtungen meiner Dissertation in jeder Hinsicht der Wahrheit entsprechen.

Wuppertal, den 1. März 2007